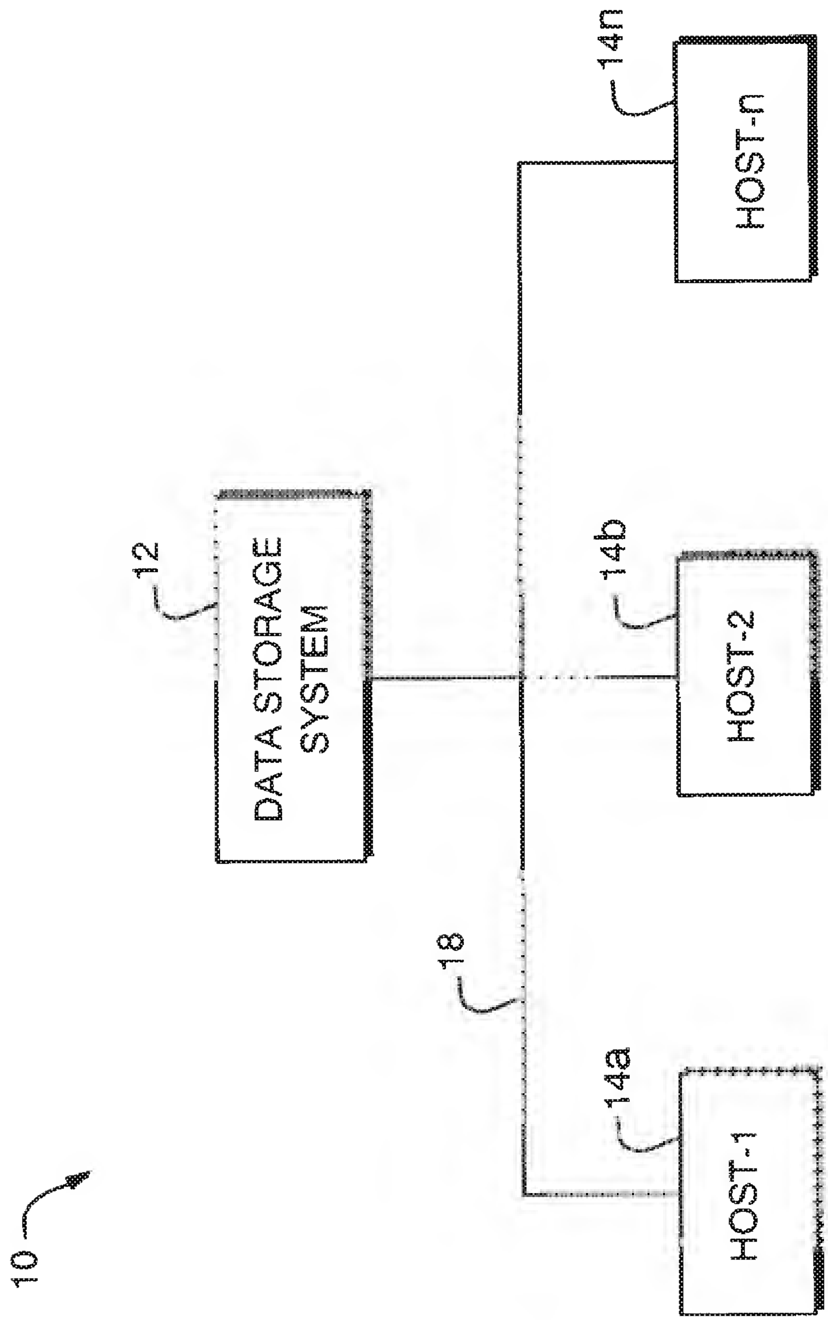


FIG. 1

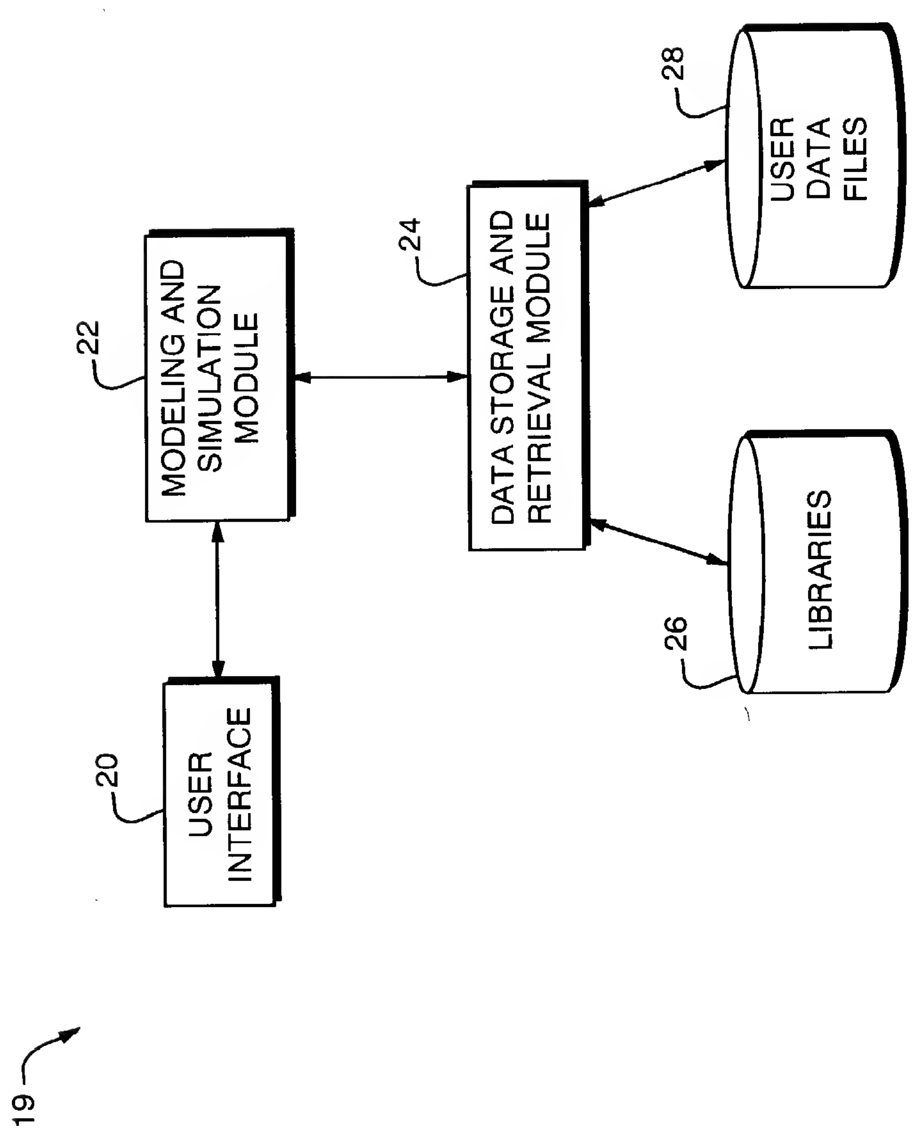

19
20
USER INTERFACE
22
MODELING AND SIMULATION MODULE
24
DATA STORAGE AND RETRIEVAL MODULE
26
LIBRARIES
28
USER DATA FILES

FIG. 2

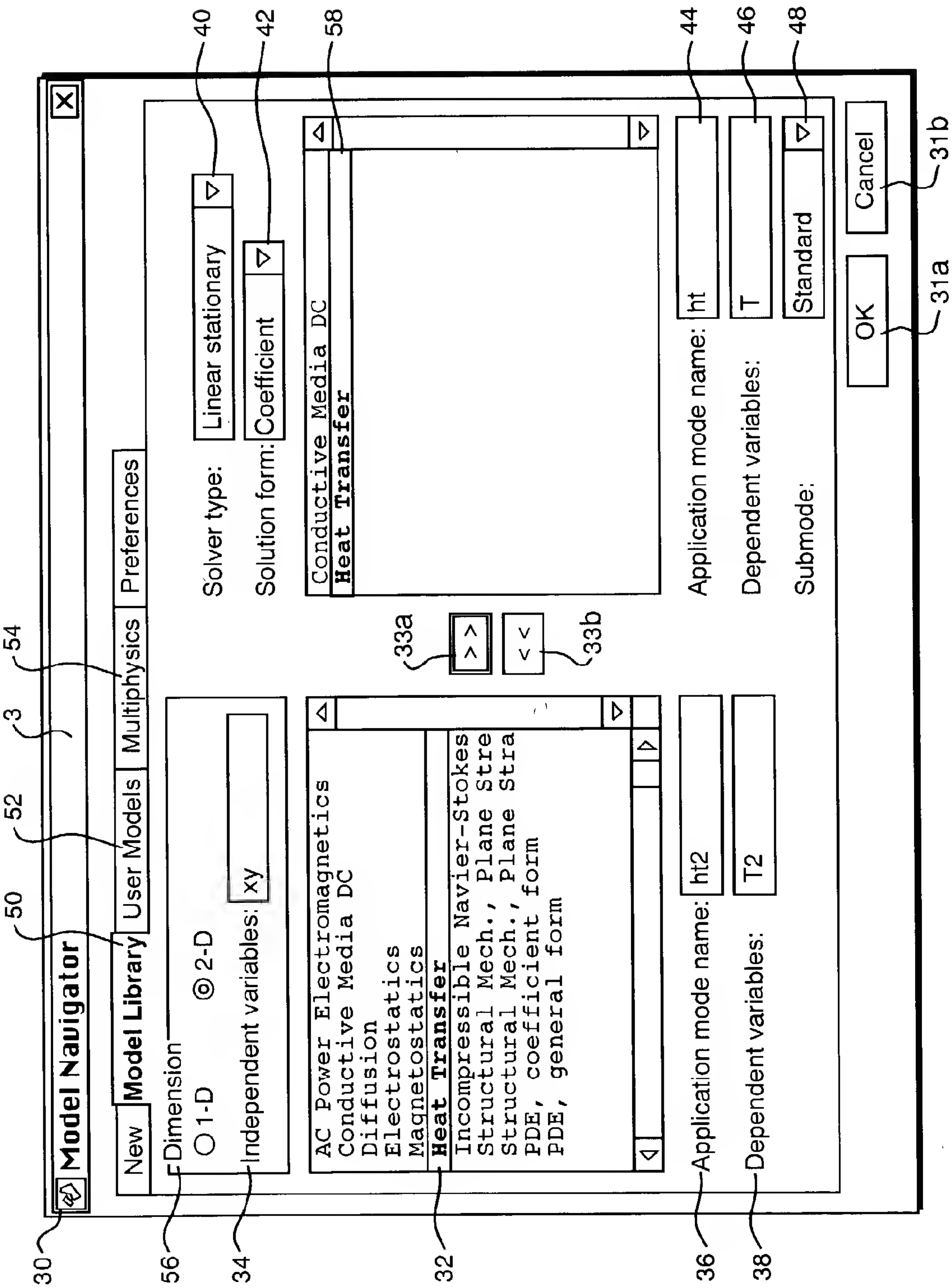

Model Navigator
New
Model Library
User Models
Multiphysics
Preferences
Dimension
1-D
2-D
Independent variables:
xy
AC Power Electromagnetics
Conductive Media DC
Diffusion
Electrostatics
Magnetostatics
Heat Transfer
Incompressible Navier-Stokes
Structural Mech.., Plane Stre
Structural Mech.., Plane Stra
PDE, coefficient form
PDE, general form
Application mode name:
ht2
Dependent variables:
T2
Solver type:
Linear stationary
Solution form:
Coefficient
Conductive Media DC
Heat Transfer
Application mode name:
ht
Dependent variables:
T
Submode:
Standard
OK
Cancel
30
56
34
32
36
38
50
52
3
54
33a
33b
40
42
58
44
46
48
31a
31b

FIG. 3

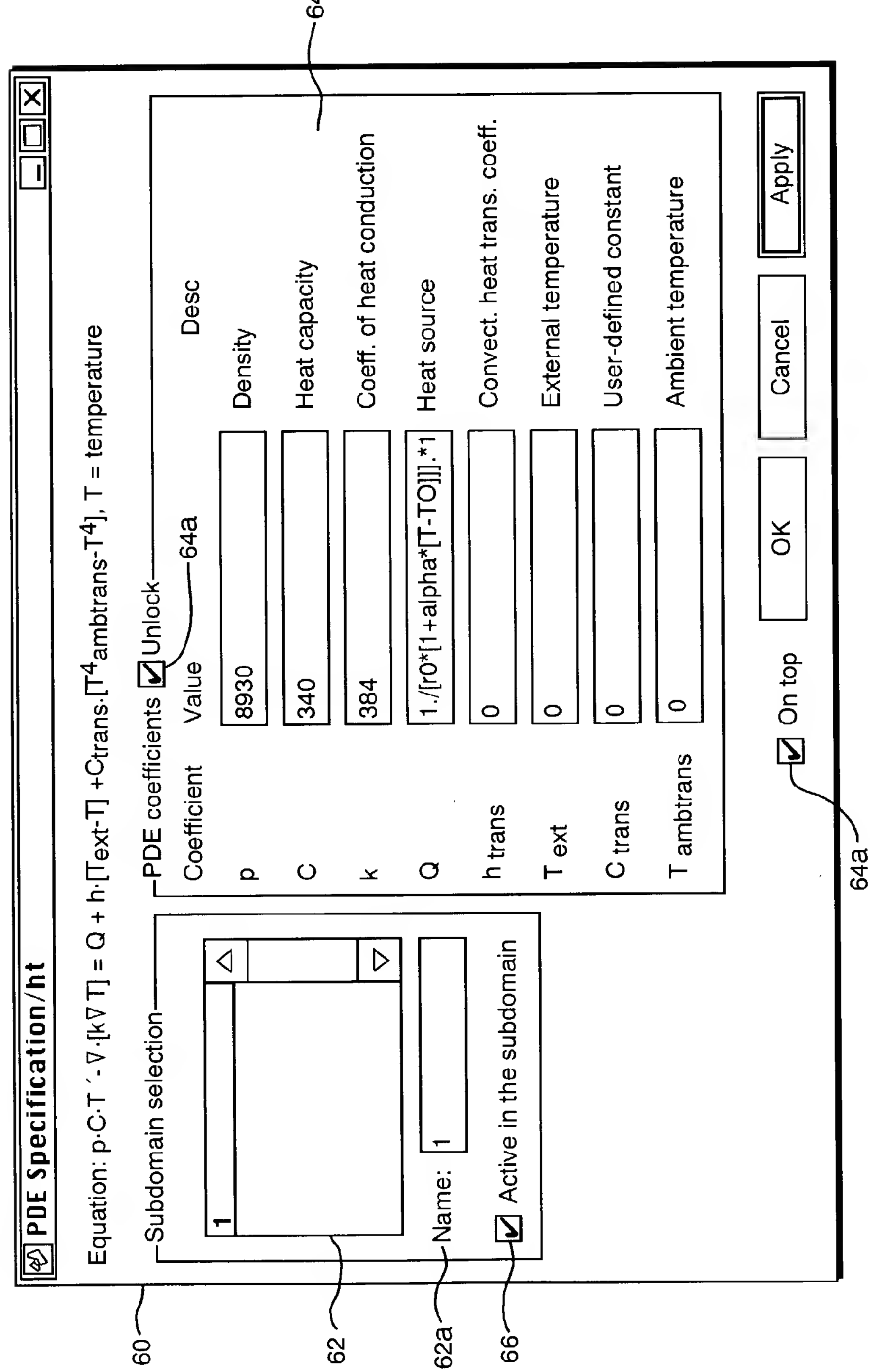
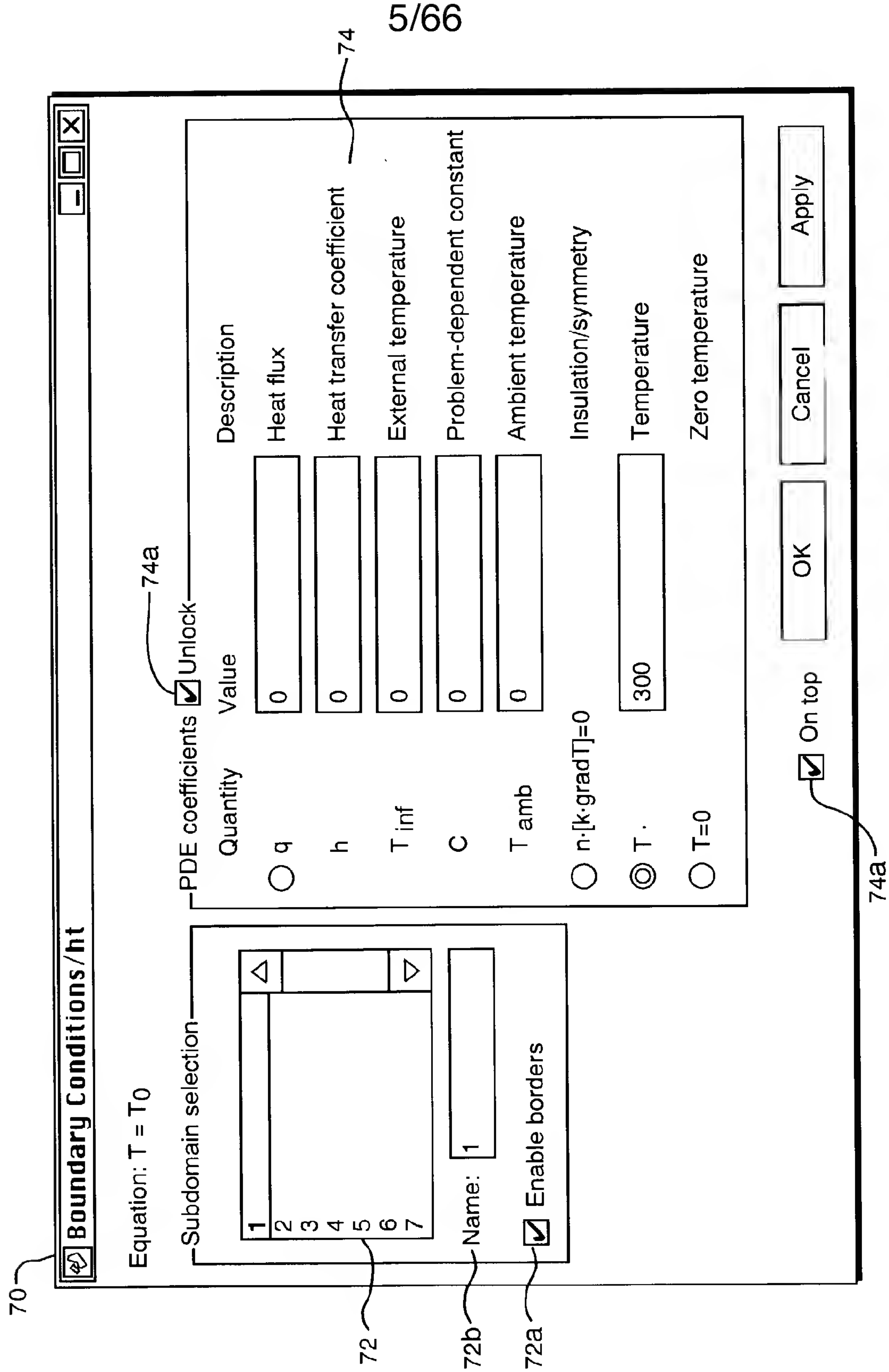

PDE Specification/ht
Equation: p·C·T´-∇·[k∇T] = Q + h·[Text-T] +Ctrans·[T4ambtrans-T4], T = temperature
Subdomain selection
1
Name:
1
Active in the subdomain
PDE coefficients
Unlock
Coefficient
Value
Desc
p
8930
Density
C
340
Heat capacity
k
384
Coeff. of heat conduction
Q
1./[r0*[1+alpha*[T-TO]]].*1
Heat source
h trans
0
Convect. heat trans. coeff.
T ext
0
External temperature
C trans
0
User-defined constant
T ambtrans
0
Ambient temperature
On top
OK
Cancel
Apply
60
62
62a
66
64
64a
64a

FIG. 4



Boundary Conditions/ht
Equation: T = To
Subdomain selection
1
2
3
4
5
6
7
Name:
1
Enable borders
PDE coefficients
Unlock
Quantity
Value
Description
q
0
Heat flux
h
0
Heat transfer coefficient
T inf
0
External temperature
C
0
Problem-dependent constant
T amb
0
Ambient temperature
n·[k·gradT]=0
Insulation/symmetry
T ·
300
Temperature
T=0
Zero temperature
On top
OK
Cancel
Apply
70
72
72b
72a
74
74a
74a

FIG. 5

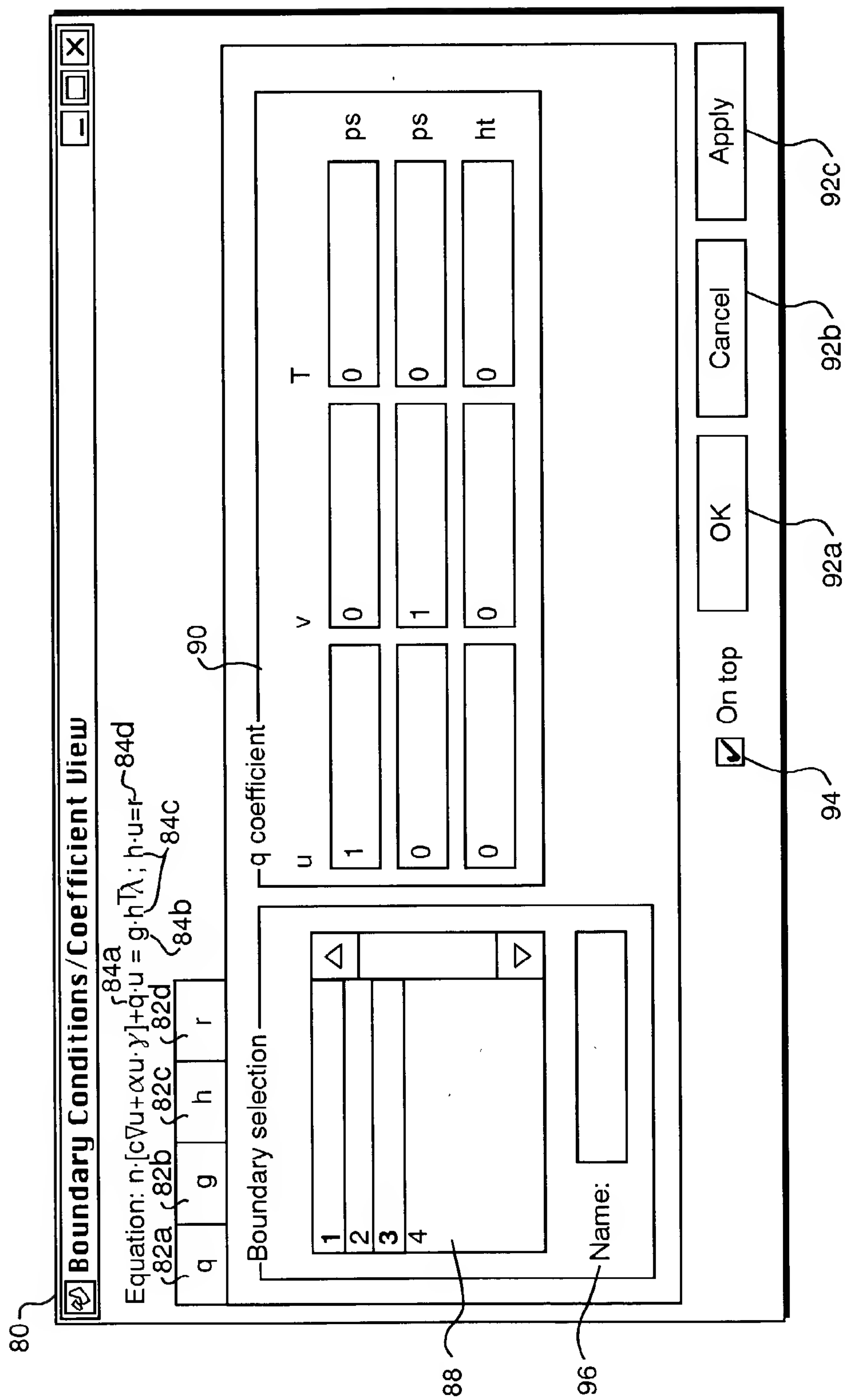

Boundary Conditions/Coefficient View
Equation: n·[c∇u+αu·γ]+q·u = g·hᵀλ; h·u=r
q
g
h
r
82a
82b
82c
82d
84a
84b
84c
84d
Boundary selection
1
2
3
4
Name:
q coefficient
u
v
T
1
0
0
0
1
0
0
0
0
ps
ps
ht
On top
OK
Cancel
Apply
80
88
90
92a
92b
92c
94
96

FIG. 6

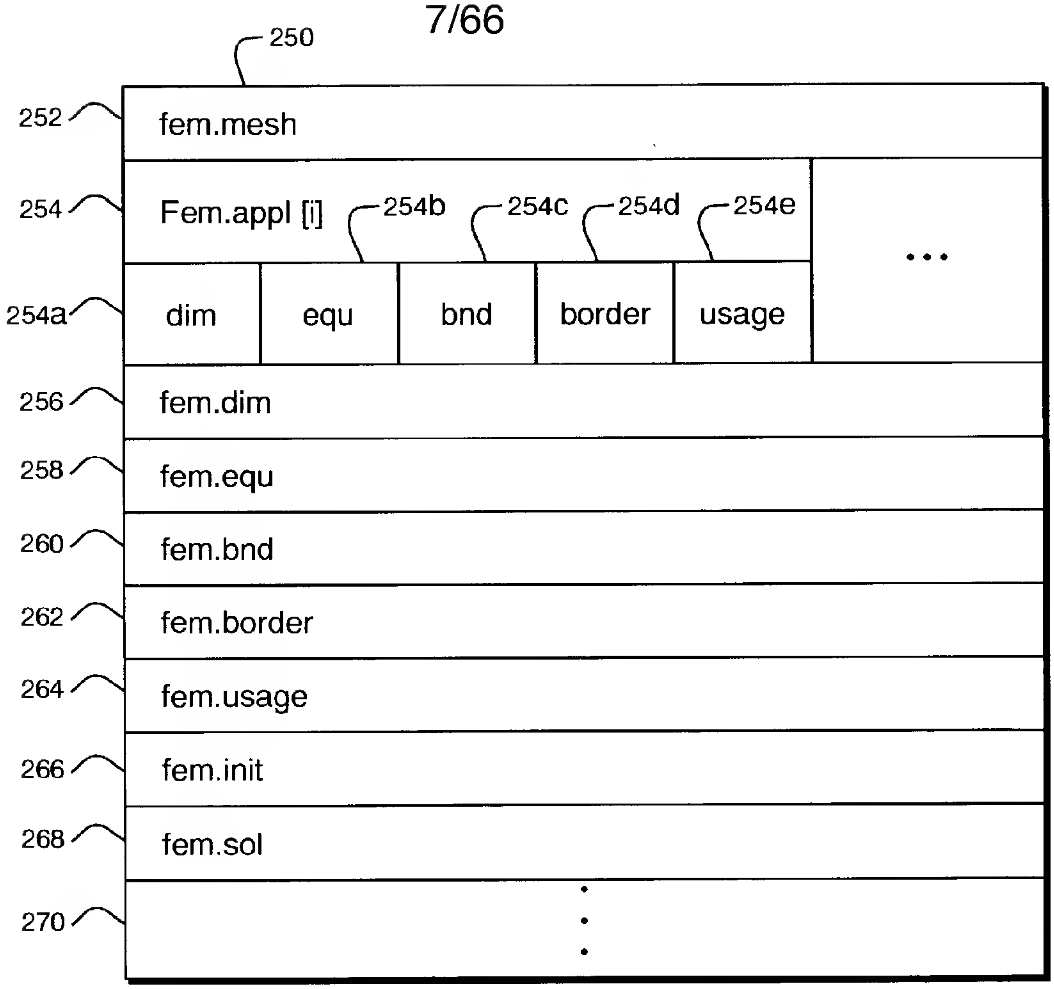
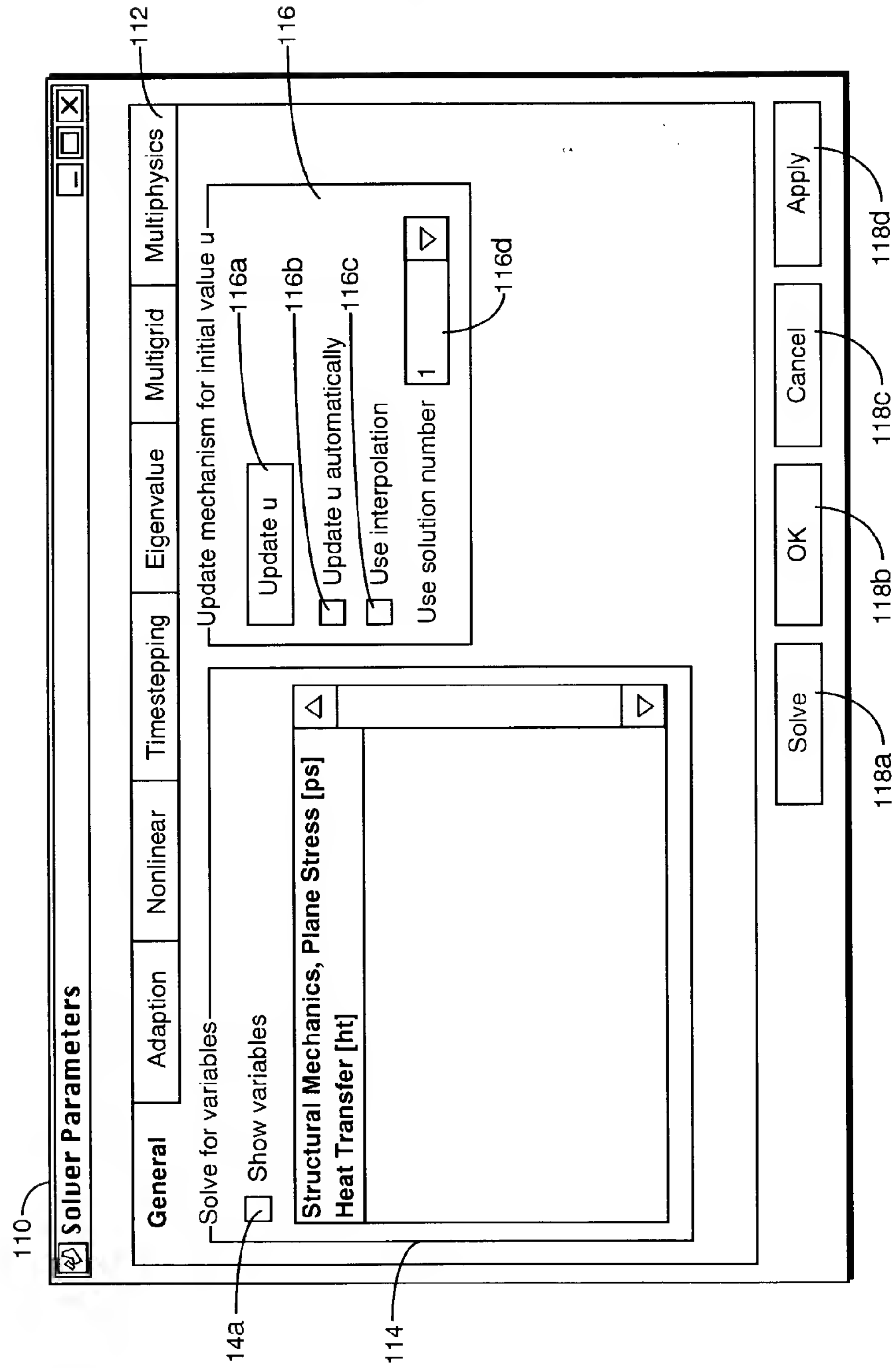

250
252
fem.mesh
254
Fem.appl [i]
254b
254c
254d
254e
254a
dim
equ
bnd
border
usage
...
256
fem.dim
258
fem.equ
260
fem.bnd
262
fem.border
264
fem.usage
266
fem.init
268
fem.sol
270

FIG. 6A



110
Solver Parameters
General
Adaption
Nonlinear
Timestepping
Eigenvalue
Multigrid
Multiphysics
112
Solve for variables
Show variables
114a
114
Structural Mechanics, Plane Stress [ps]
Heat Transfer [ht]
Update mechanism for initial value u
116
Update u
116a
Update u automatically
116b
Use interpolation
116c
Use solution number
1
116d
Solve
118a
OK
118b
Cancel
118c
Apply
118d

FIG. 7

$$140\begin{cases} d_{a\,lk}\dfrac{\partial u_k}{\partial t} - \dfrac{\partial}{\partial x_j}\left(c_{lkji}\dfrac{\partial u_k}{\partial x_i} + \alpha_{lkj}u_k - \gamma_{lj}\right) + \beta_{lki}\dfrac{\partial u_k}{\partial x_i} + a_{lk}u_k = f_i & \Big\rangle\,\Omega \quad 142 \\ n_j\left(c_{lkji}\dfrac{\partial u_k}{\partial x_i} + \alpha_{lkj}u_k - \gamma_{lj}\right) + q_{lk}u_k = g_l - h_{ml}\lambda_m & \Big\rangle\,\partial\Omega \quad 146a \\ h_{ml}u_l = r_m & \Big\rangle\,\partial\Omega \quad 146b \end{cases} \Bigg\rangle\ 146$$

FIG. 8

$$150\begin{cases} d_{a\,lk}\dfrac{\partial u_k}{\partial t} + \dfrac{\partial \Gamma_{lj}}{\partial x_j} = F_l & \Omega\,\Big\rangle \quad 152 \\ \sim n_j\Gamma_{lj} = G_l + \dfrac{\partial R_m}{\partial u_l}\lambda_m & \partial\Omega\,\Big\rangle \quad 154a \\ O = R_m & \partial\Omega\,\Big\rangle \quad 154b \end{cases} \Bigg\rangle\ 154$$

FIG. 9

$$324\ \left\{\begin{array}{ll}
\gamma_{lj} = \Gamma_{lj} & f_l = F_l \\[2ex]
c_{lkji} = -\dfrac{\partial \Gamma_{lj}}{\partial\left(\dfrac{\partial n_k}{\partial x_i}\right)} & \alpha_{lkj} = -\dfrac{\partial \Gamma_{lj}}{\partial u_k} \\[2ex]
\beta_{lki} = -\dfrac{\partial F_l}{\partial\left(\dfrac{\partial m_k}{\partial x_i}\right)} & a_{lk} = -\dfrac{\partial F_l}{\partial u_k} \\[2ex]
g_l = G_l & r_l = R_l \\[2ex]
q_{lk} = -\dfrac{\partial G_l}{\partial u_k} & h_{lk} = -\dfrac{\partial R_l}{\partial u_k}
\end{array}\right.$$

FIG. 10

$$240 \left\{ \begin{aligned} \Gamma_{lj} &= -c_{lkji} \frac{\partial u_k}{\partial x_l} - \alpha_{lkj} u_k + \gamma_{lj} \\ F_l &= f_l - \beta_{lki} \frac{\partial u_k}{\partial x_i} - a_{lk} u_k \\ G_l &= g_l - q_{lk} u_k \\ R_m &= r_m - h_{ml} u_l \end{aligned} \right.$$

FIG. 11

$$300 \left\{ \begin{array}{l} \int_{\Omega} \left(\left(c_{lkji} \frac{\partial u_k}{\partial x_i} \pm \alpha_{lkj} u_k \right) \frac{\partial v}{\partial x_j} + \left(d_{a\,lk} \frac{\partial u_k}{\partial l} + \beta_{lki} \frac{\partial u_k}{\partial x_i} + a_{lk} u_k \right) v \right) dx + \\ \\ \int_{\partial\Omega} q_{lk} u_k v ds = \int_{\Omega} \left(\gamma_{lj} \frac{\partial v}{\partial x_j} + f_l v \right) dx + \int_{\partial\Omega} (g_l - h_{ml} \lambda_m) v ds \\ \\ \int_{\partial\Omega} \mu h_{mk} u_k ds = \int_{\partial\Omega} \mu r_m ds \end{array} \right.$$

FIG. 12

$$302 \left\{ \begin{array}{l} \int_{\Omega} \left(\Gamma_{lj} \frac{\partial v}{\partial x_j} + F_{lv} - d_{alk} \frac{\partial u_k}{\partial l} v \right) dx + \int_{\partial \Omega} + \left(G_l + \frac{\partial R_m}{\partial u_l} \lambda_m \right) v ds = O \\ \int_{\partial \Omega} R_m \mu ds = O \end{array} \right.$$

FIG. 13

304

$$U_k(x) = \sum_{I=1}^{N_p} U_{I.k} \Phi_I(x); \qquad \Lambda_m(x) = \sum_{k=1}^{N_c} \sum_{L=l}^{n} \Lambda_{K,L,m} \Psi_{K,L}(x)$$

FIG. 14

$$306\begin{cases} \int_t \left(c_{lkji}\, U_{I,k} \frac{\partial \Phi_l}{\partial x_i} + \alpha_{lkj} U_{I,k} \Phi_I \right) \frac{\partial \Phi_J}{\partial x_j}\, dx + \\ \int_t \left(d_{a\,lk} \frac{\partial U_{I,k}}{\partial l}\, \Phi_I + \beta_{lki} U_{I,k} \frac{\partial \Phi_I}{\partial x_i} + a_{lk}\, U_{I,k} \Phi_I \right) \Phi_J\, dx + \\ \int_{\partial t} q_{lk} U_{I,k} \Phi_I \Phi_j\, ds = \int_t \left(\gamma_{lj} \frac{\partial \Phi_J}{\partial x_j} + f_l \Phi_J \right) dx + \\ \int_{\partial t} (g_l - h_{ml} \Lambda_{K,L,m} \Psi_{K,L})\, \Phi_J\, ds \end{cases}$$

FIG. 15

$$308\left\{\begin{array}{l}\int h_{mk} U_{I,k} \Phi_{I} \Psi_{K,L}\, ds = \int r_{m} \Psi_{K,L}\, ds \\ \partial t\end{array}\right.$$

FIG. 16

$$312\left\{\begin{array}{l}\int_t\left(\Gamma_{lj}\frac{\partial\Phi_j}{\partial x_j}+F_l\Phi_j-d_{alk}\frac{\partial u_k}{\partial t}\Phi_J\right)dx+\int_{\partial t}+\left(G_l+\frac{\partial R_m}{\partial u_l}\Lambda_{K,L,m}\Psi_{K,L}\right)\Phi_J\,ds=O\\ \int_{\partial t}R_m\Psi_{K,L}\,ds=O\end{array}\right.$$

FIG. 17

310

$$DA_{(J,l),(I,k)}=\int_t d\ a\ {}_{lk}\Phi_I\Phi_J\,dx$$

$$C_{(J,l),(I,k)}=\int_t c_{lkji}\frac{\partial\Phi_I}{\partial x_i}?\frac{\partial\Phi_J}{\partial x_j}\,dx$$

$$AL_{(J,l),(I,k)}=\int_t \alpha_{lkj}\Phi_I?\frac{\partial\Phi_J}{\partial x_j}\,dx$$

$$BE_{(J,l),(I,k)}=\int_t \beta_{lki}\frac{\partial\Phi_I}{\partial x_i}\Phi_J\,dx$$

$$A_{(J,l),(I,k)}=\int_t a_{lk}\Phi_I\Phi_J\,dx$$

$$Q_{(J,l),(I,k)}=\int_{\partial t} q_{lk}\Phi_I\Phi_J\,ds$$

$$GA_{(J,l)}=\int_t \gamma_{lj}\frac{\partial\Phi_J}{\partial x_j}\,dx$$

$$F_{(J,l)}=\int_t f_l\Phi_J\,dx$$

$$G_{(J,l)}=\int_{\partial t} g_l\Phi_J\,ds$$

$$H_{(K,L,m),(I,k)}=\int_{\partial t} h_{mk}\Phi_I\Psi_{K,L}\,ds$$

$$R_{(K,L,m)}=\int_{\partial t} r_m\Psi_{K,L}\,ds$$

FIG. 18

$$320 \left\{ \begin{array}{l} DA\,\dfrac{\partial U}{\partial t} + (C+AL+BE+A+Q)\,U + H^{T}\Lambda = GA+F+G \\[2ex] HU=R \end{array} \right.$$

FIG. 19

$$322 \left\{ \begin{array}{l} DA \dfrac{\partial U}{\partial t} + H^T \Lambda = GA + F + G \\ R = O \end{array} \right.$$

FIG. 20

$$326 \begin{cases} J\,(U^{(k)})\,\Delta U^{(k)} = -\rho(U^{(k)}) \\ U^{(k+1)} = U^{(k)} + \lambda_k \Delta U^{(k)} \end{cases}$$

FIG. 21

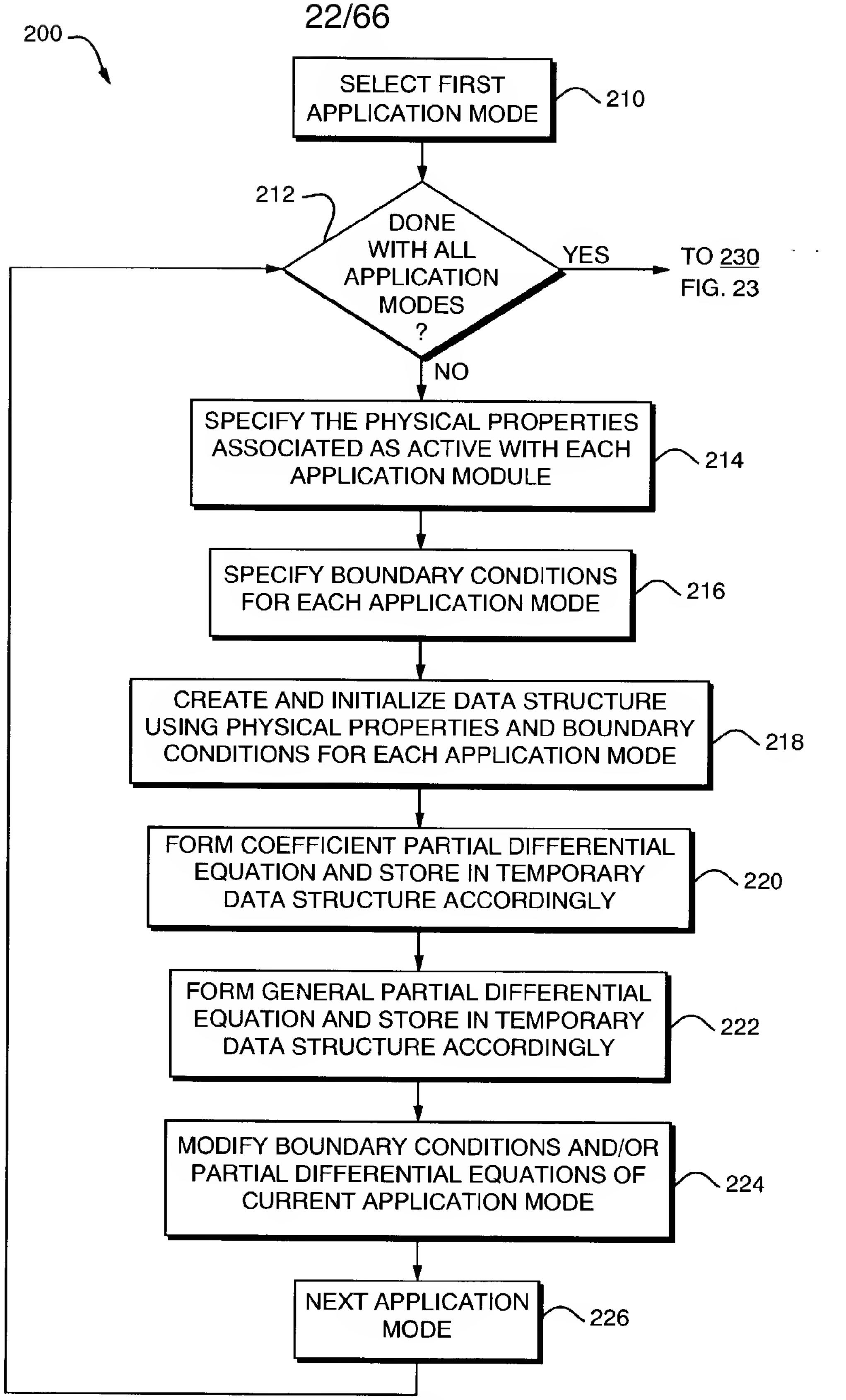

200
SELECT FIRST APPLICATION MODE
210
212
DONE WITH ALL APPLICATION MODES ?
YES
TO 230 FIG. 23
NO
SPECIFY THE PHYSICAL PROPERTIES ASSOCIATED AS ACTIVE WITH EACH APPLICATION MODULE
214
SPECIFY BOUNDARY CONDITIONS FOR EACH APPLICATION MODE
216
CREATE AND INITIALIZE DATA STRUCTURE USING PHYSICAL PROPERTIES AND BOUNDARY CONDITIONS FOR EACH APPLICATION MODE
218
FORM COEFFICIENT PARTIAL DIFFERENTIAL EQUATION AND STORE IN TEMPORARY DATA STRUCTURE ACCORDINGLY
220
FORM GENERAL PARTIAL DIFFERENTIAL EQUATION AND STORE IN TEMPORARY DATA STRUCTURE ACCORDINGLY
222
MODIFY BOUNDARY CONDITIONS AND/OR PARTIAL DIFFERENTIAL EQUATIONS OF CURRENT APPLICATION MODE
224
NEXT APPLICATION MODE
226

FIG. 22

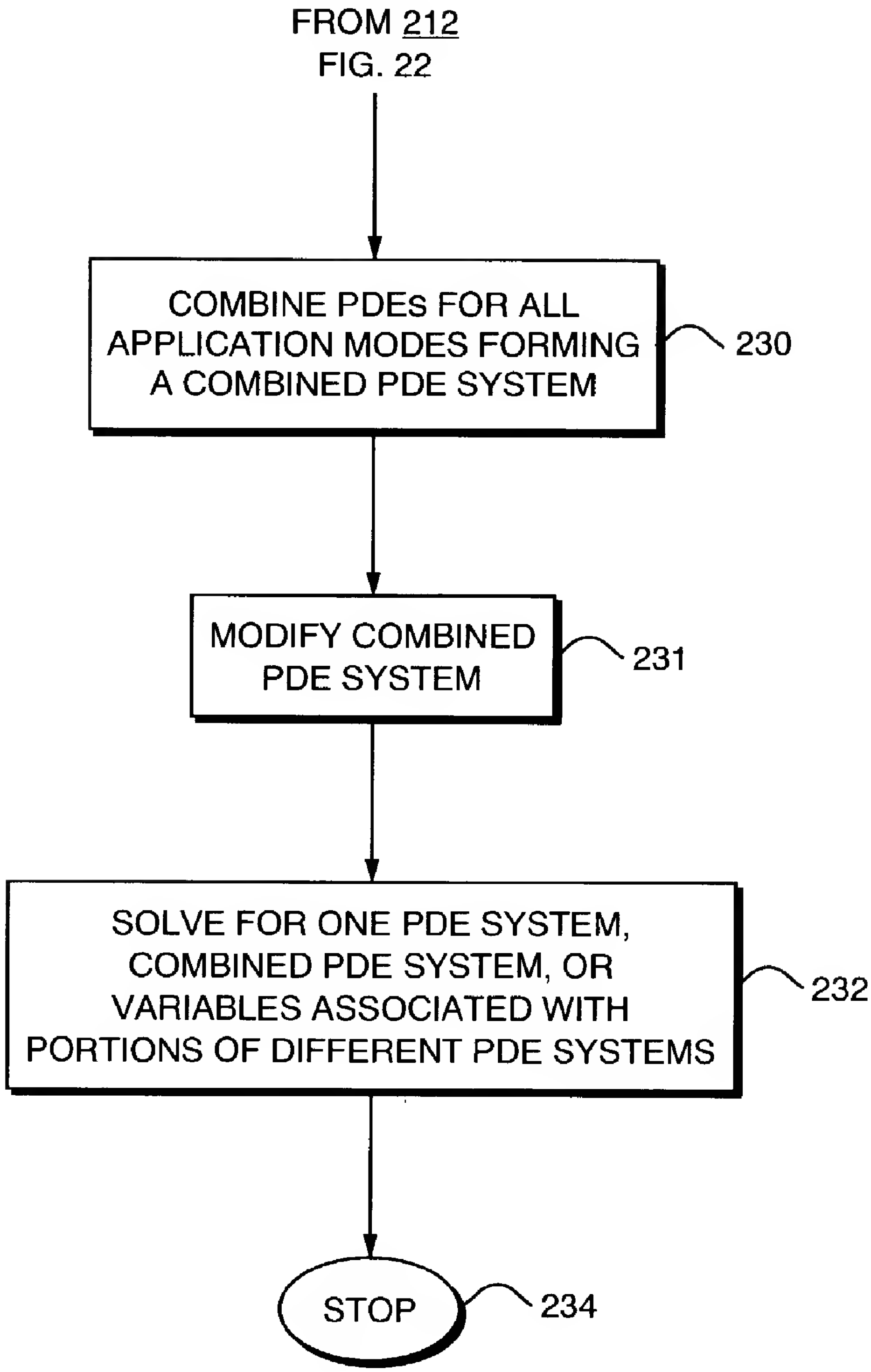

FROM 212
FIG. 22
COMBINE PDEs FOR ALL APPLICATION MODES FORMING A COMBINED PDE SYSTEM
230
MODIFY COMBINED PDE SYSTEM
231
SOLVE FOR ONE PDE SYSTEM, COMBINED PDE SYSTEM, OR VARIABLES ASSOCIATED WITH PORTIONS OF DIFFERENT PDE SYSTEMS
232
STOP
234

FIG. 23

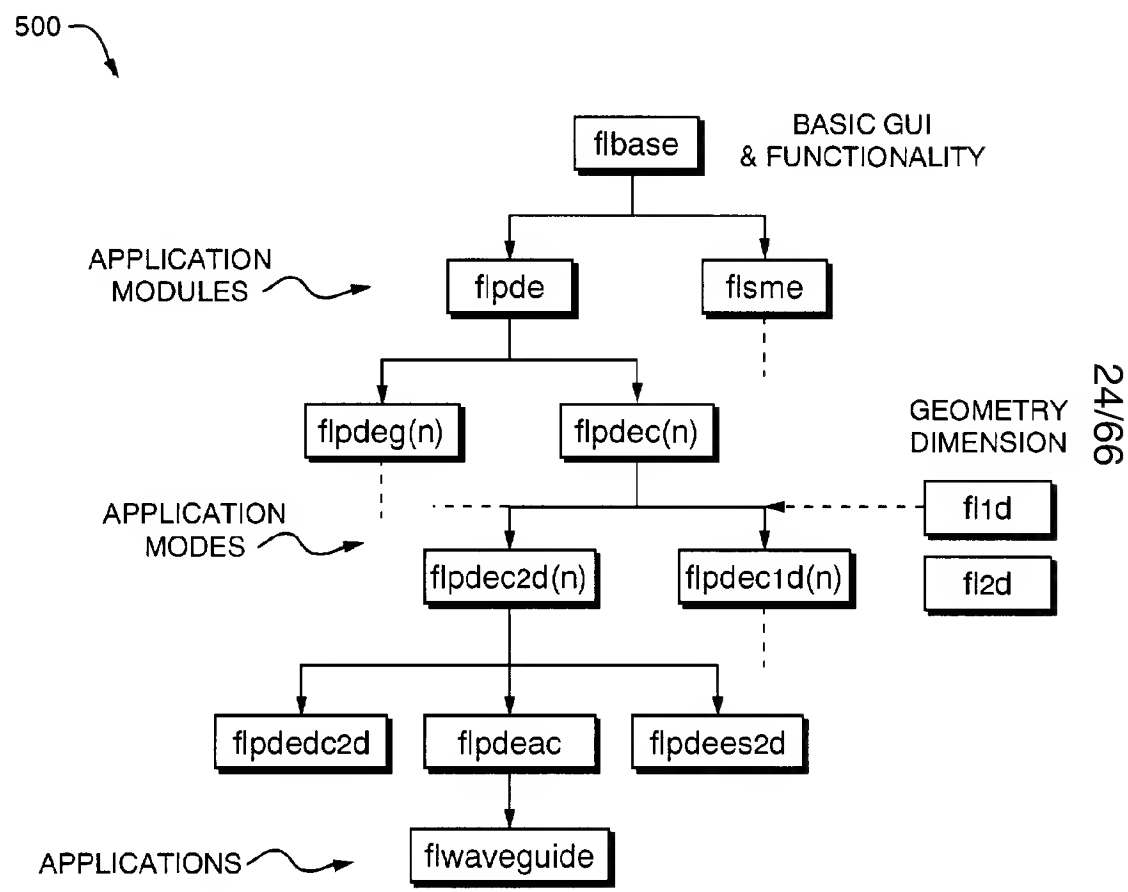

500
flbase
BASIC GUI
& FUNCTIONALITY
APPLICATION
MODULES
flpde
flsme
flpdeg(n)
flpdec(n)
GEOMETRY
DIMENSION
fl1d
fl2d
APPLICATION
MODES
flpdec2d(n)
flpdec1d(n)
flpdedc2d
flpdeac
flpdees2d
APPLICATIONS
flwaveguide

FIG. 24

1-D PHYSICS APPLICATION MODES

APPLICATION MODE	CLASS NAME	PARENT CLASS
DIFFUSION	flpdedf1d	flpdedf
HEAT TRANSFER	flpdeht1d	flpdeht

502

1-D PDE APPLICATION MODES

APPLICATION MODE	CLASS NAME	PARENT CLASS
COEFFICIENT PDE MODEL, n VARIABLES	flpdecf1d*(n)*	flpdecf*(n)*
GENERAL PDE MODEL, n VARIABLES	flpdegt1d*(n)*	flpdegt*(n)*

504

FIG. 25

2-D PHYSICS APPLICATION MODES

APPLICATION MODE	CLASS NAME	PARENT CLASS
AC POWER ELECTROMAGNETICS	flpdeac	flpdec2d
CONDUCTIVE MEDIA DC	flpdedc2d	flpdedc
DIFFUSION	flpdedf2d	flpdedf
ELECTROSTATICS	flpdees2d	flpdees
MAGNETOSTATICS	flpdems2d	flpdems
HEAT TRANSFER	flpdeht2d	flpdeht
INCOMPRESSIBLE NAVIER-STOKES	flpdens2d	flpdens
STRUCTURAL MECHANICS, PLANE STRESS	flpdeps	flpdec2d
STRUCTURAL MECHANICS, PLANE STRAIN	flpdepn	flpdec2d

506

PDE APPLICATION MODES

APPLICATION MODE	CLASS NAME	PARENT CLASS
COEFFICIENT PDE MODEL, n VARIABLES	flpdec2d*(n)*	flpdec*(n)*
GENERAL PDE MODEL, n VARIABLES	flpdeg2d*(n)*	flpdeg*(n)*

508

FIG. 26

510

APPLICATION OBJECT PROPERTIES

Property name	Description	Data type
dim	Names of the dependent variables	Cell array of strings
form	PDE form	String (coefficient/general)
name	Application name	String
parent	Parent class names	String, cell array of strings, or the empty matrix
sdim	Names of the independent variables (space dimensions)	Cell array of strings
submode	Name of current submode	String (std/wave)
tdiff	Time differentiation flag	String (on/off)

FIG. 27

512

```
function obj = myapp()
%MYAPP Constructor for a FEMLAB appplication object.

obj.name = 'My first FEMLAB application';
obj.parent = 'flpdeht2d':

%MYAPP is a subclass of FLPDEHT2D;
p1 = flpdeht2d;
obj = class(obj,'myapp',p1);
sat(obj,'dim',default_dim(obj));
```

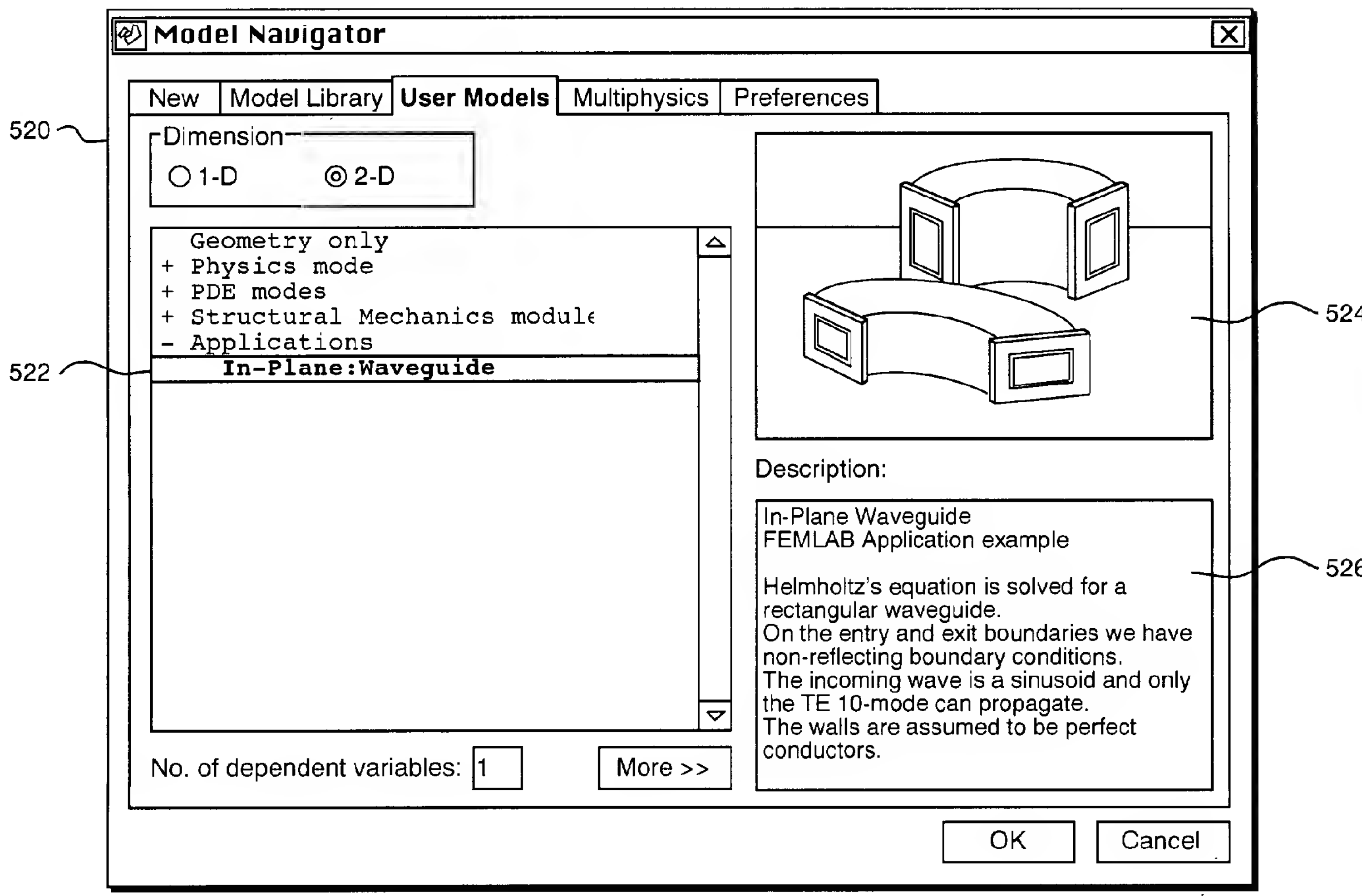
FIG. 28

PHYSICS MODELING METHODS

514

FUNCTION	PURPOSE
appspec	Return application specifications
bnd_compute	Convert application-dependent boundary conditions to generic boundary coefficients.
default_bnd	Default boundary conditions.
default_dim	Default names of dependent variables.
default_equ	Default PDE coefficients/material parameters.
default_init	Default intitial conditions.
default_sdim	Default space dimension variables.
default_var	Default application scalar variables.
dim_compute	Return dependent variables for an application
equ_compute	Convert application-dependent material parameters to generic PDE coefficients.
form_compute	Return PDE form.
init_compute	Convert application-dependent initial conditions to generic initial conditions.
posttable	Define assigned variable names and post-processing information.

FIG. 29



520
522
524
526
Model Navigator
New
Model Library
User Models
Multiphysics
Preferences
Dimension
1-D
2-D
Geometry only
+ Physics mode
+ PDE modes
+ Structural Mechanics module
- Applications
In-Plane:Waveguide
No. of dependent variables: 1
More >>
Description:
In-Plane Waveguide
FEMLAB Application example
Helmholtz's equation is solved for a rectangular waveguide.
On the entry and exit boundaries we have non-reflecting boundary conditions.
The incoming wave is a sinusoid and only the TE 10-mode can propagate.
The walls are assumed to be perfect conductors.
OK
Cancel

FIG. 30

FIG. 31

530 $\Delta E_z + (2\pi ik)^2 E_z = 0$

532 $k = \frac{1}{\lambda} = \frac{f}{c}$

534 $\bar{n}, (\nabla E_z) + 2\pi ik_x E_z = 4\pi ik_x \sin\left(\frac{\pi}{d}(y - y_0)\right)$

536 $k^2 = k_x^2 + k_y^2$

538 $k_x = \sqrt{\frac{1}{\lambda^2} - \frac{1}{(2d)^2}}$

540 $n \cdot (\nabla E_z) + 2\pi ik_x E_z = 0$

542 $E_z = 0$

544 $f_c = \frac{c}{2d}$

550

```
function obj = flwaveguide(varargin)
%FLWAVEGUIDE Constructor for a Waveguide application object

obj.name = 'In-Plane Waveguide';
obj.parent = 'flpdeac';

%FLWAVEGUIDE is a subclass of FLPDEAC:
p1 = flpdeac;
obj = class(obj,'flwaveguide',p1);
set(obj,'dim',default_dim(obj));
```

FIG. 32

fem.user fields

field	description
geomparam	1-by-2 structure of geometry parameters.
entrybnd	Index to the entry boundary
exitbnd	Index to the exit boundary.
freqs	Frequency vector

552

FIG. 33

554

fem.user fields

field	description
startpt	Index of the lower left corner point of the waveguide.
type	Type of waveguide. ('*straight* or '*elbow*)

FIG. 34

geoparam fields

field	description	defaults for elbow	default for straight
entrylength	Length of the entrance part of the waveguide.	0.1	0.1
exitlength	Length of the exit part of the waveguide.	0.1	not used
radius	Outer radius of the waveguide bend.	0.05	not used
width	Width of the waveguide.	0.025	0.025
cavityflag	Turn resonance cavity *on* or *off.*	0	0
cavitywidth	Width of the resonance cavity.	0.025	0.025
postwidth	Width of the protruding posts.	0.005	0.005
postdepth	Depth of the protruding posts.	0.005	0.005

FIG. 35

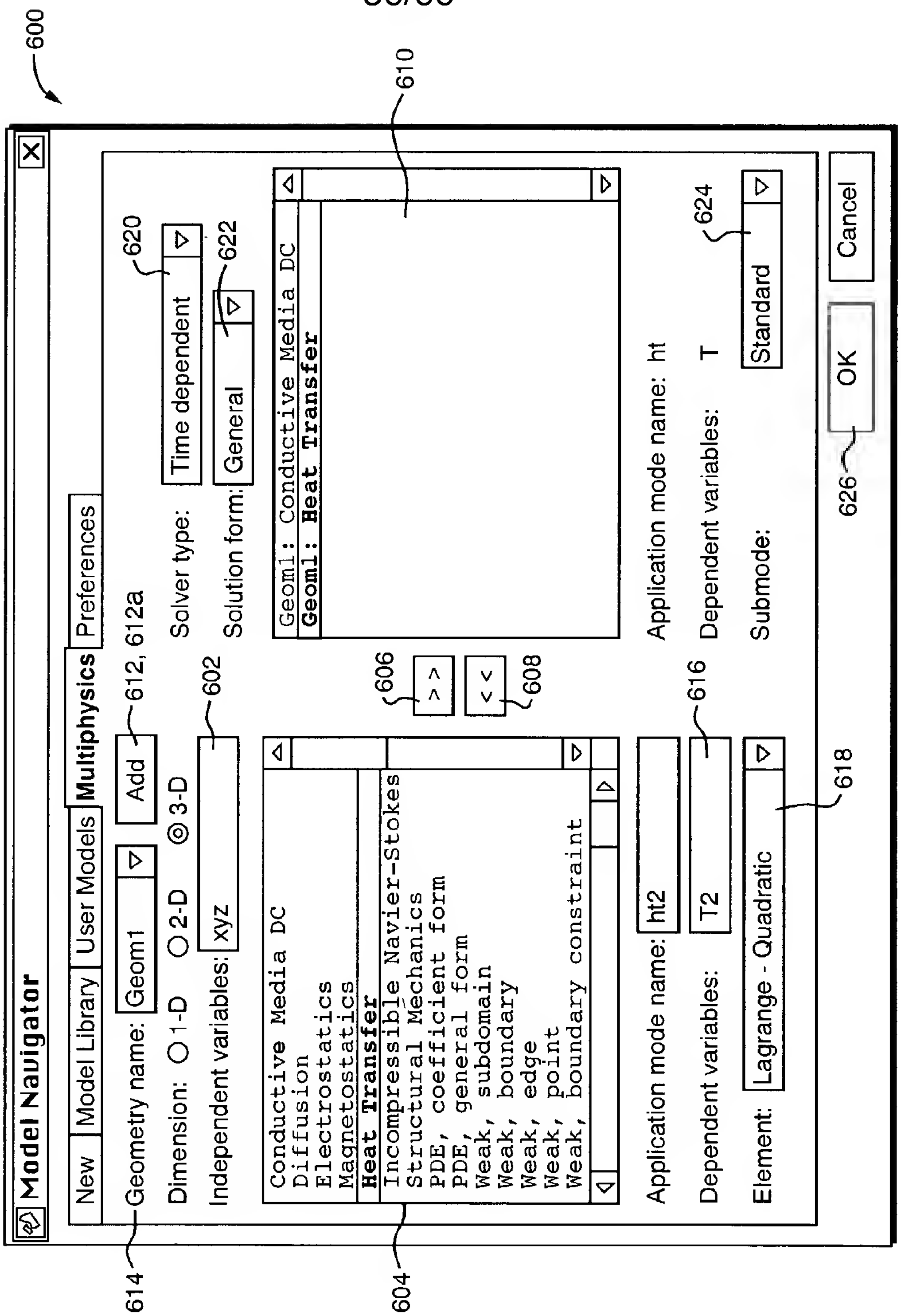

600
Model Navigator
New
Model Library
User Models
Multiphysics
Preferences
Geometry name:
Geom1
Add
612, 612a
Dimension:
1-D
2-D
3-D
Independent variables:
xyz
602
Solver type:
Time dependent
620
Solution form:
General
622
Conductive Media DC
Diffusion
Electrostatics
Magnetostatics
Heat Transfer
Incompressible Navier-Stokes
Structural Mechanics
PDE, coefficient form
PDE, general form
Weak, subdomain
Weak, boundary
Weak, edge
Weak, point
Weak, boundary constraint
604
614
> >
606
< <
608
Geom1: Conductive Media DC
Geom1: Heat Transfer
610
Application mode name:
ht2
Dependent variables:
T2
616
Element:
Lagrange - Quadratic
618
Application mode name: ht
Dependent variables: T
Submode:
Standard
624
OK
Cancel
626

FIG. 36

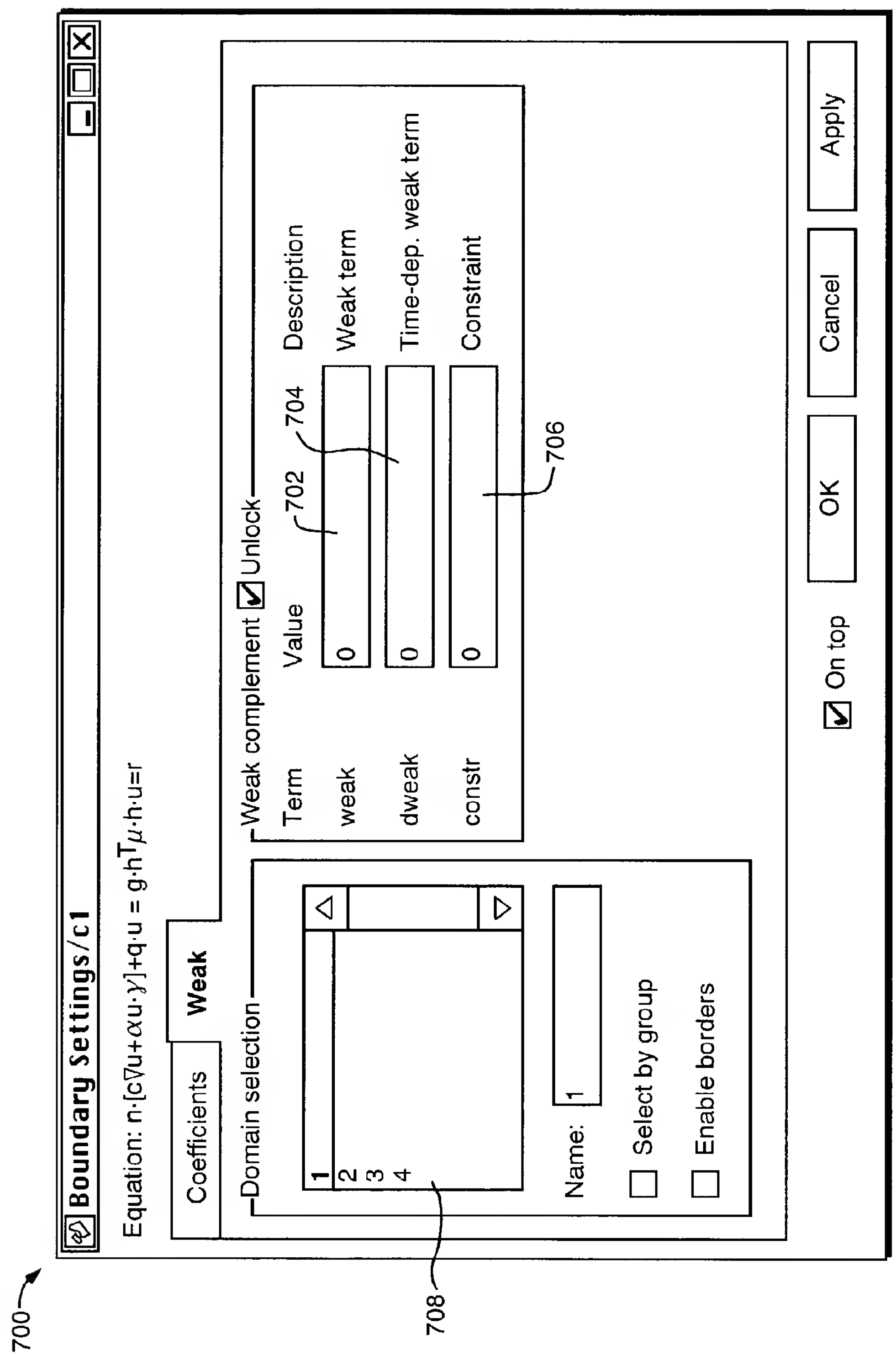

700
Boundary Settings/c1
Equation: n·[c∇u+αu·γ]+q·u = g·h^Tμ·h·u=r
Coefficients
Weak
Domain selection
1
2
3
4
Name: 1
Select by group
Enable borders
Weak complement
Unlock
Term
Value
Description
weak
0
Weak term
dweak
0
Time-dep. weak term
constr
0
Constraint
702
704
706
708
On top
OK
Cancel
Apply

FIG. 37

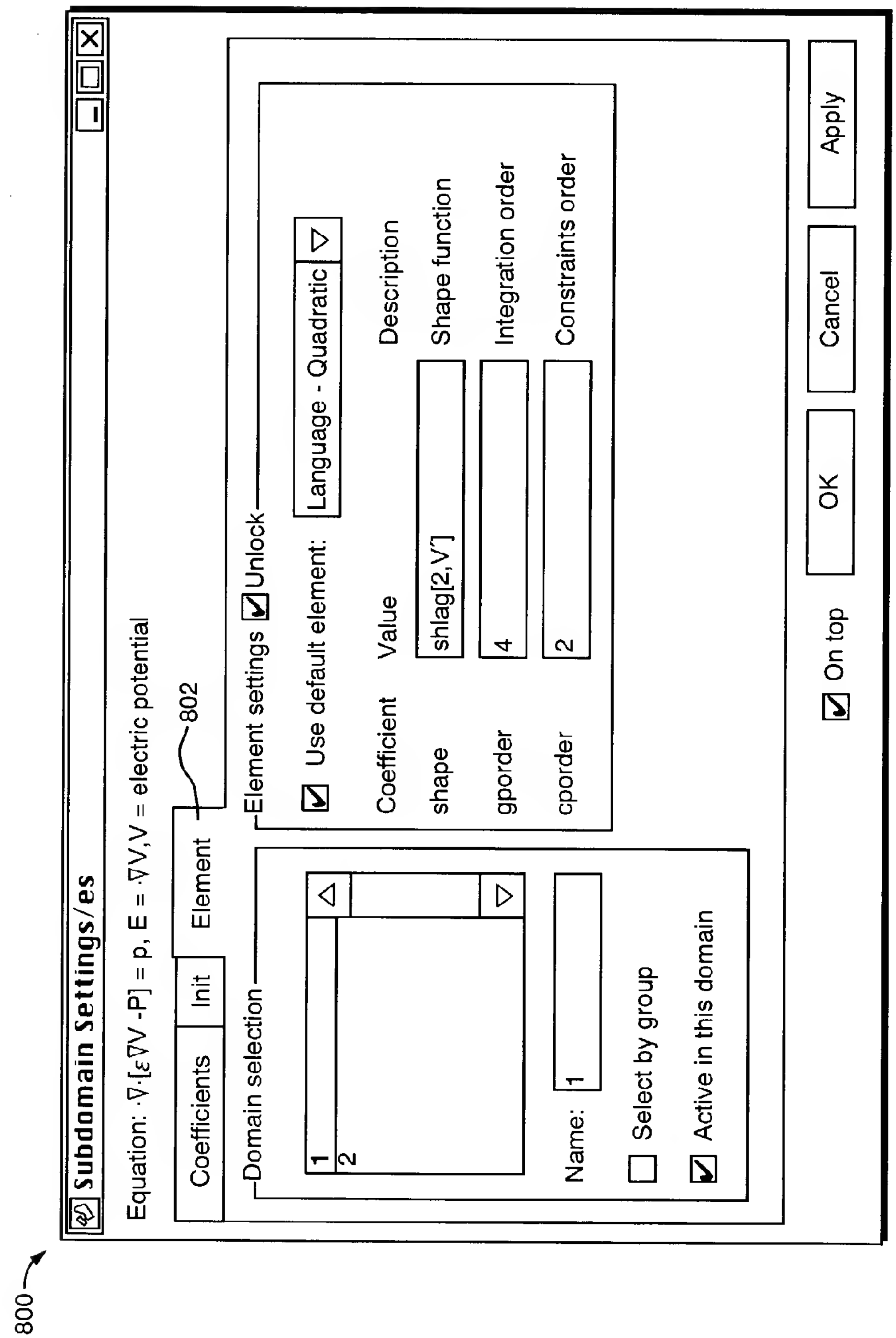

800
Subdomain Settings/es
Equation: $\nabla\cdot[\varepsilon\nabla V - P] = \rho$, $E = -\nabla V$, V = electric potential
802
Coefficients
Init
Element
Domain selection
1
2
Name:
1
Select by group
Active in this domain
Element settings
Unlock
Use default element:
Language - Quadratic
Coefficient
Value
Description
shape
shlag[2,'V']
Shape function
gporder
4
Integration order
cporder
2
Constraints order
On top
OK
Cancel
Apply

FIG. 38

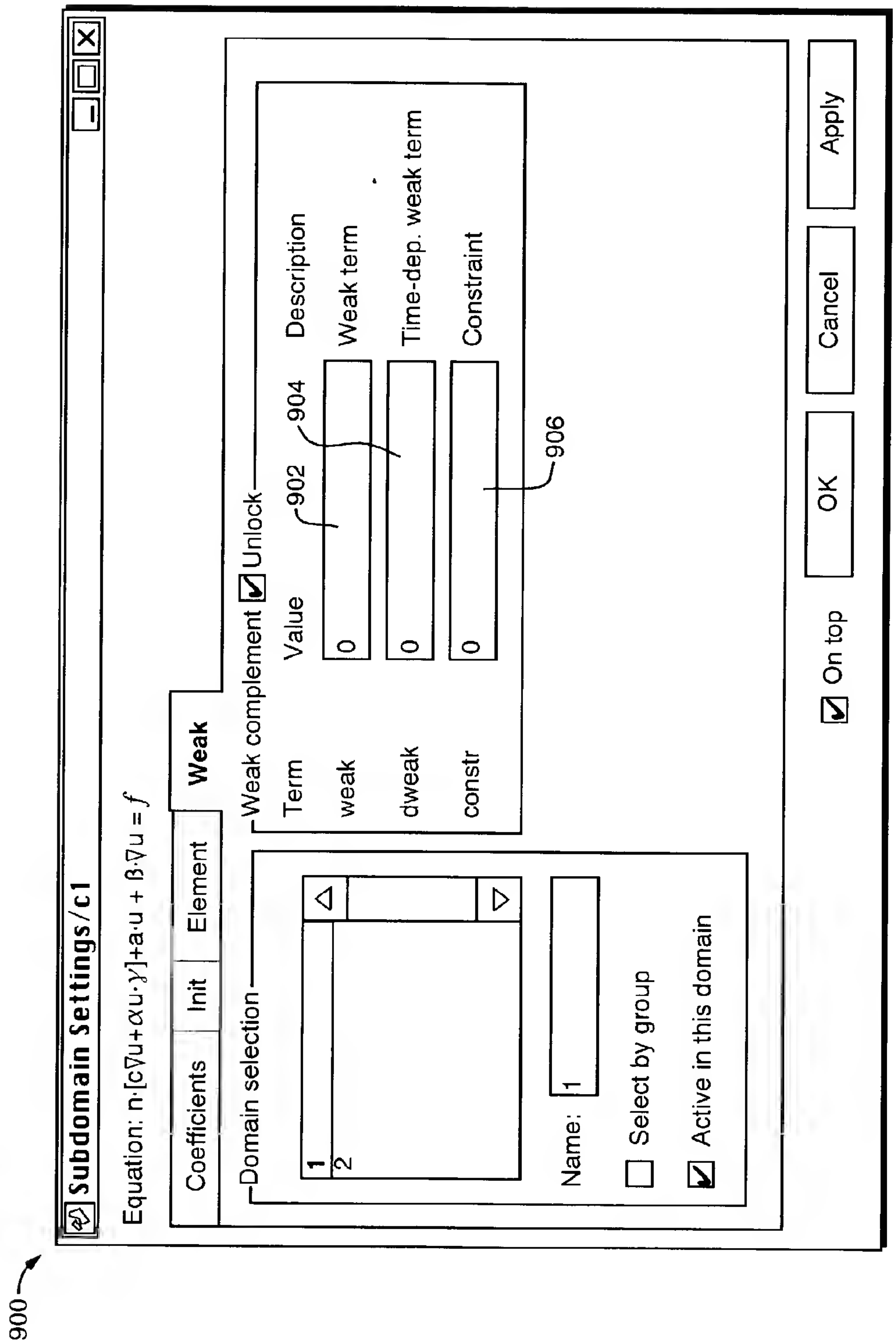

Subdomain Settings/c1
Equation: n·[c∇u+αu·γ]+a·u + β·∇u = f
Coefficients
Init
Element
Weak
Domain selection
1
2
Name: 1
Select by group
Active in this domain
Weak complement
Unlock
Term
Value
Description
weak
0
Weak term
dweak
0
Time-dep. weak term
constr
0
Constraint
902
904
906
On top
OK
Cancel
Apply
900

FIG. 39

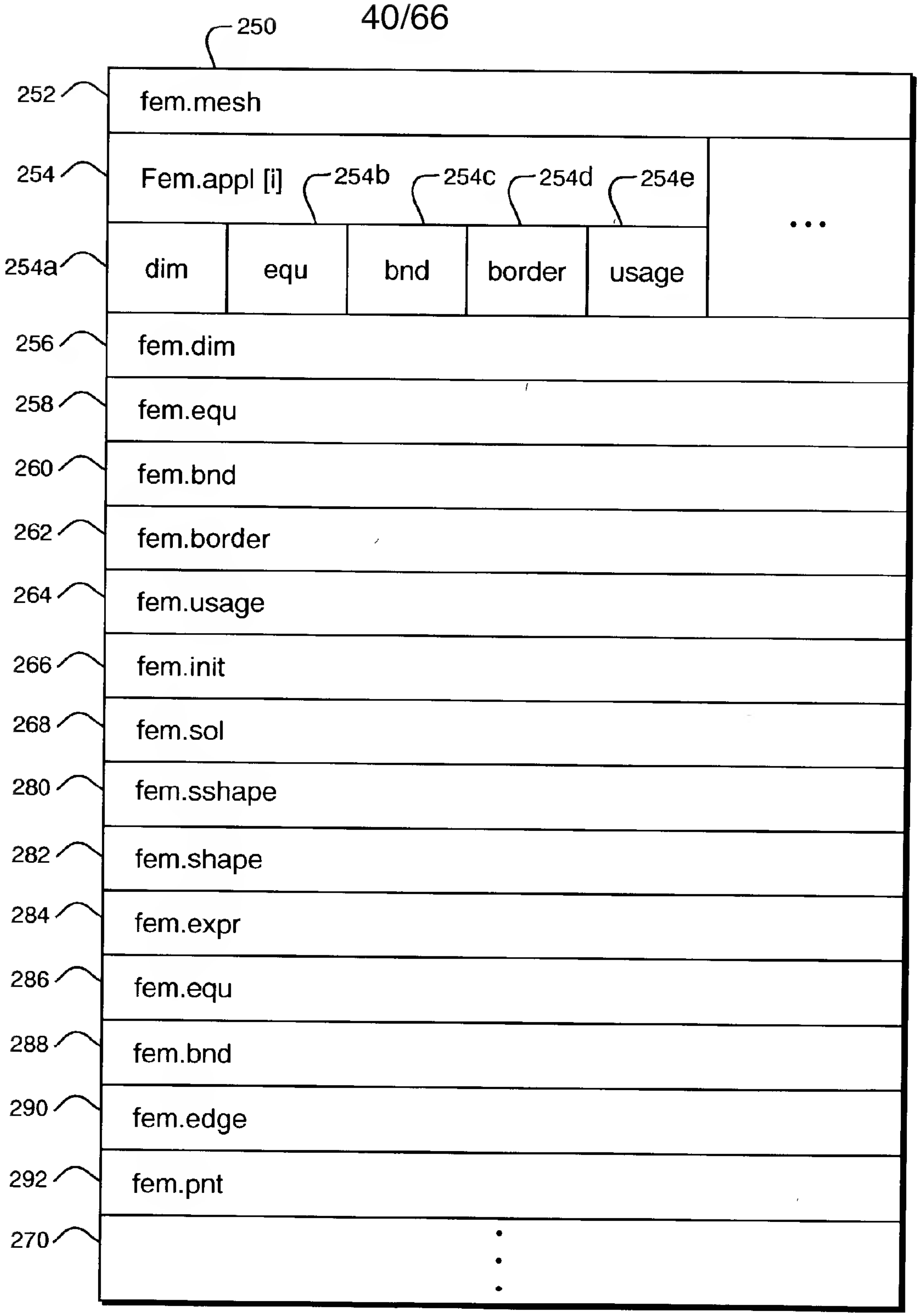

250
252
fem.mesh
254
Fem.appl [i]
254b
254c
254d
254e
254a
dim
equ
bnd
border
usage
256
fem.dim
258
fem.equ
260
fem.bnd
262
fem.border
264
fem.usage
266
fem.init
268
fem.sol
280
fem.sshape
282
fem.shape
284
fem.expr
286
fem.equ
288
fem.bnd
290
fem.edge
292
fem.pnt
270

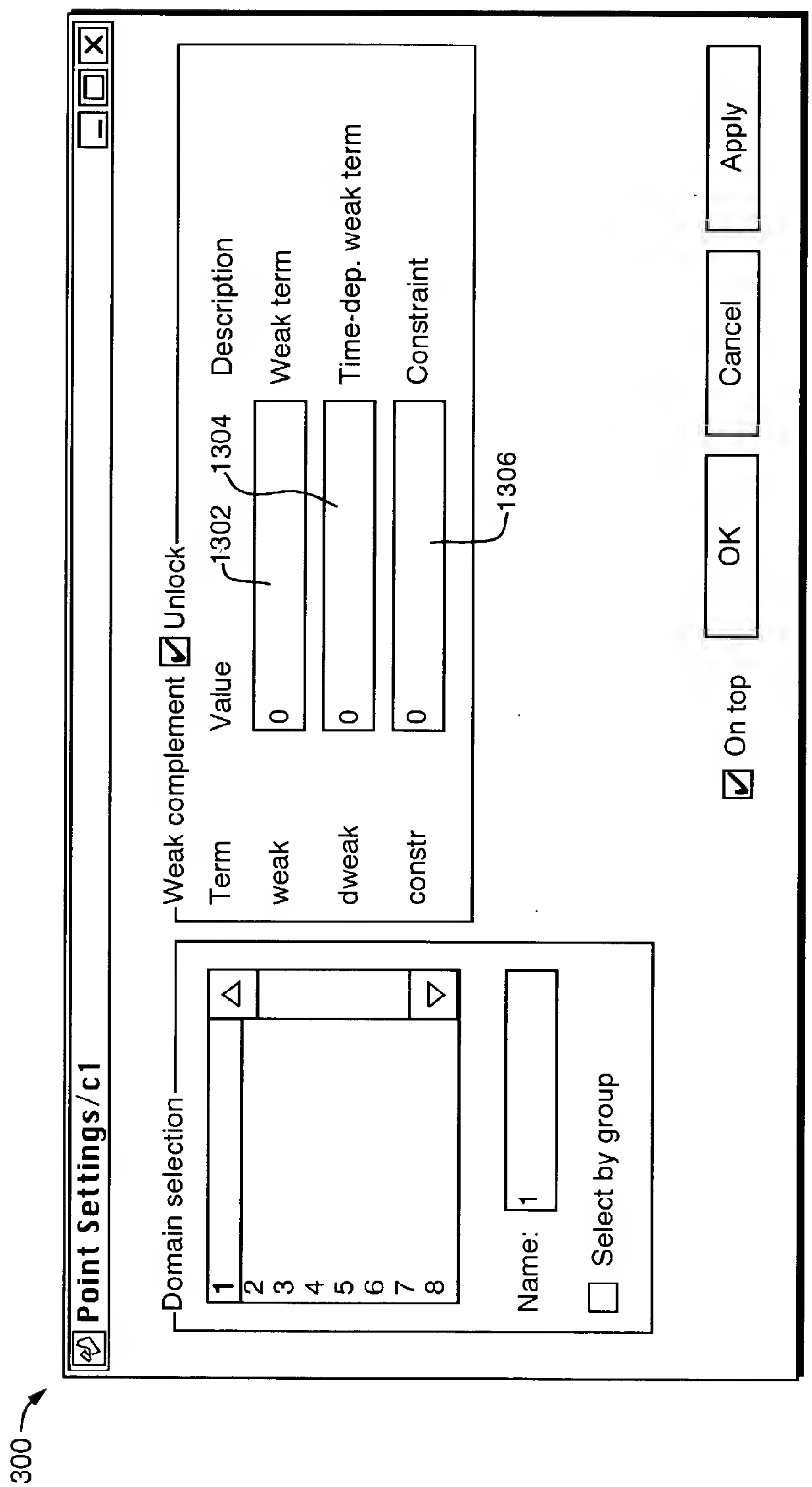
FIG. 40

$$
1100 \left\{
\begin{array}{l}
1102 \left\{
\begin{array}{l}
0 = \int_{\Omega} W^{(2)} d\,A \;\; \int_{B} W^{(1)} ds + \sum_{P} W^{(0)} + \\
+ \int_{\Omega} v_l \frac{\partial R_m^{(2)}}{\partial U_l} \mu_m^{(2)} dA + \int_{B} v_l \frac{\partial Rm^{(1)}}{\partial u_l} \mu_m^{(1)} ds + \sum_{P} v_l \frac{\partial Rm^{(0)}}{\partial u_l} \mu_m^{(0)}
\end{array}
\right. \\[2em]
1104 \left\{
\begin{array}{ll}
0 = R^{(2)} & \text{on } \Omega \\
0 = R^{(1)} & \text{on } B \\
0 = R^{(0)} & \text{on } P
\end{array}
\right.
\end{array}
\right.
$$

FIG. 41

$$
1200 \left\{
\begin{aligned}
& W_l^{(n)} = W_l^{(n)} + \Gamma_{lj} \frac{\partial v_l}{\partial x_j} + F_l v_l \\
& W_l^{(nt)} = W_l^{(nt)} + d_{alk} \frac{\partial u_k}{\partial t} v_l \\
& W_l^{(n\text{-}l)} = W_l^{(n\text{-}l)} + G_l v_l \\
& R_m^{(n)} = R_m
\end{aligned}
\right.
$$

FIG. 42



1300
Point Settings/c1
Domain selection
1
2
3
4
5
6
7
8
Name:
1
Select by group
Weak complement
Unlock
Term
Value
Description
weak
0
Weak term
dweak
0
Time-dep. weak term
constr
0
Constraint
1302
1304
1306
On top
OK
Cancel
Apply

FIG. 43

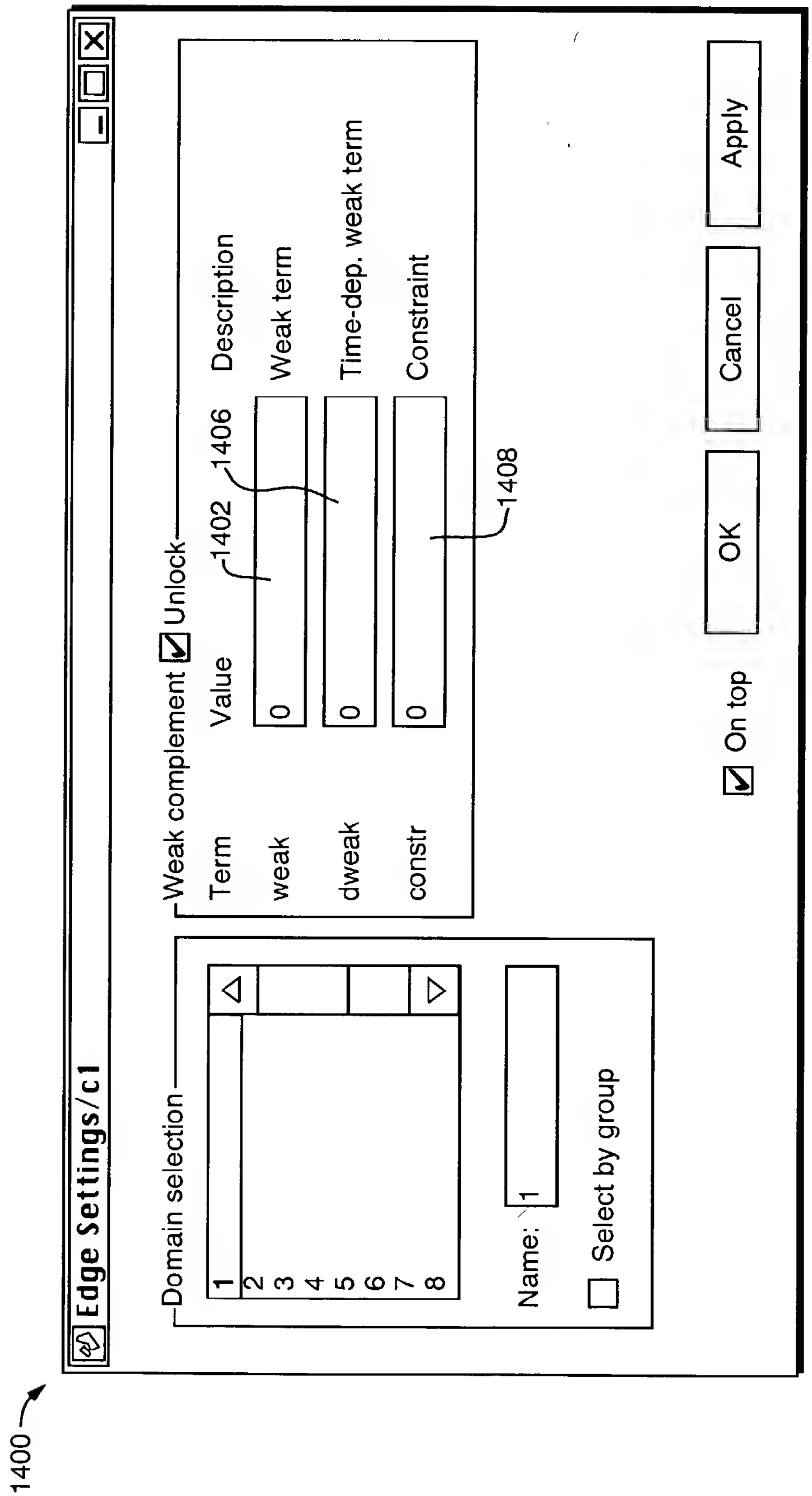

1400
Edge Settings/c1
Domain selection
1
2
3
4
5
6
7
8
Name:
1
Select by group
Weak complement
Unlock
Term
Value
Description
1402
1406
weak
0
Weak term
dweak
0
Time-dep. weak term
constr
0
Constraint
1408
On top
OK
Cancel
Apply

FIG. 44

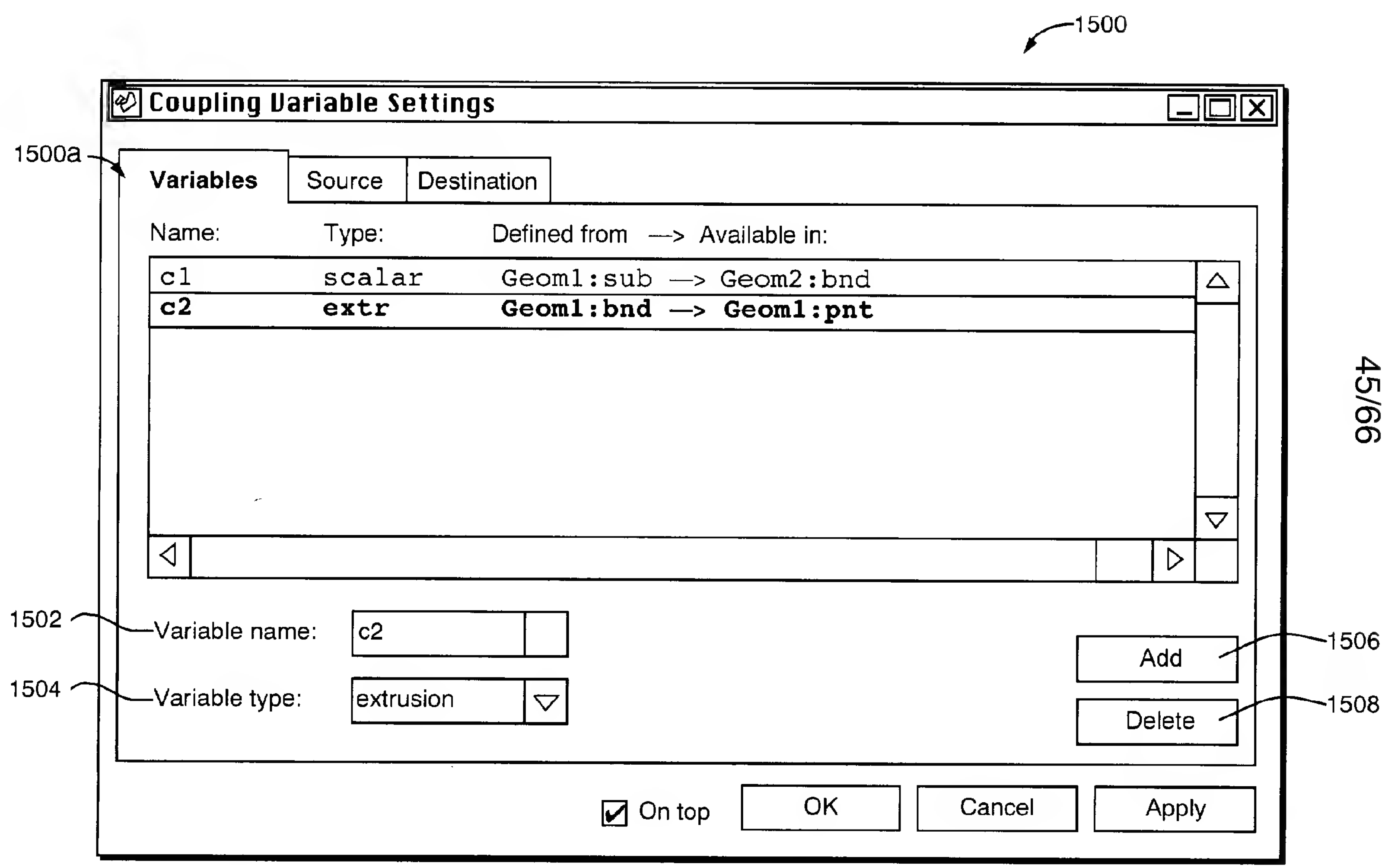

1500
Coupling Variable Settings
1500a
Variables
Source
Destination
Name:
Type:
Defined from —> Available in:
c1
scalar
Geom1:sub —> Geom2:bnd
c2
extr
Geom1:bnd —> Geom1:pnt
1502
Variable name:
c2
1504
Variable type:
extrusion
Add
1506
Delete
1508
On top
OK
Cancel
Apply

FIG. 45A

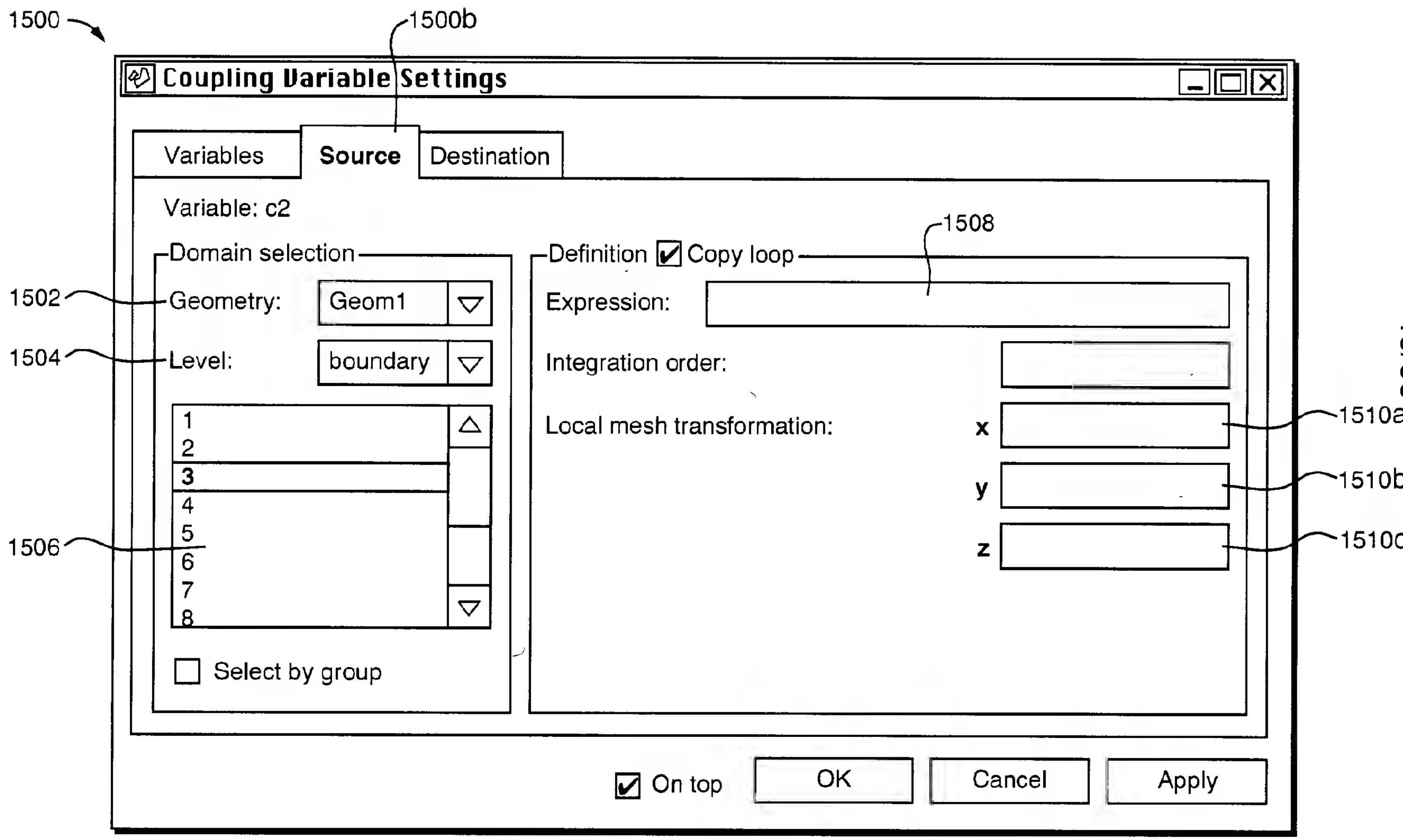
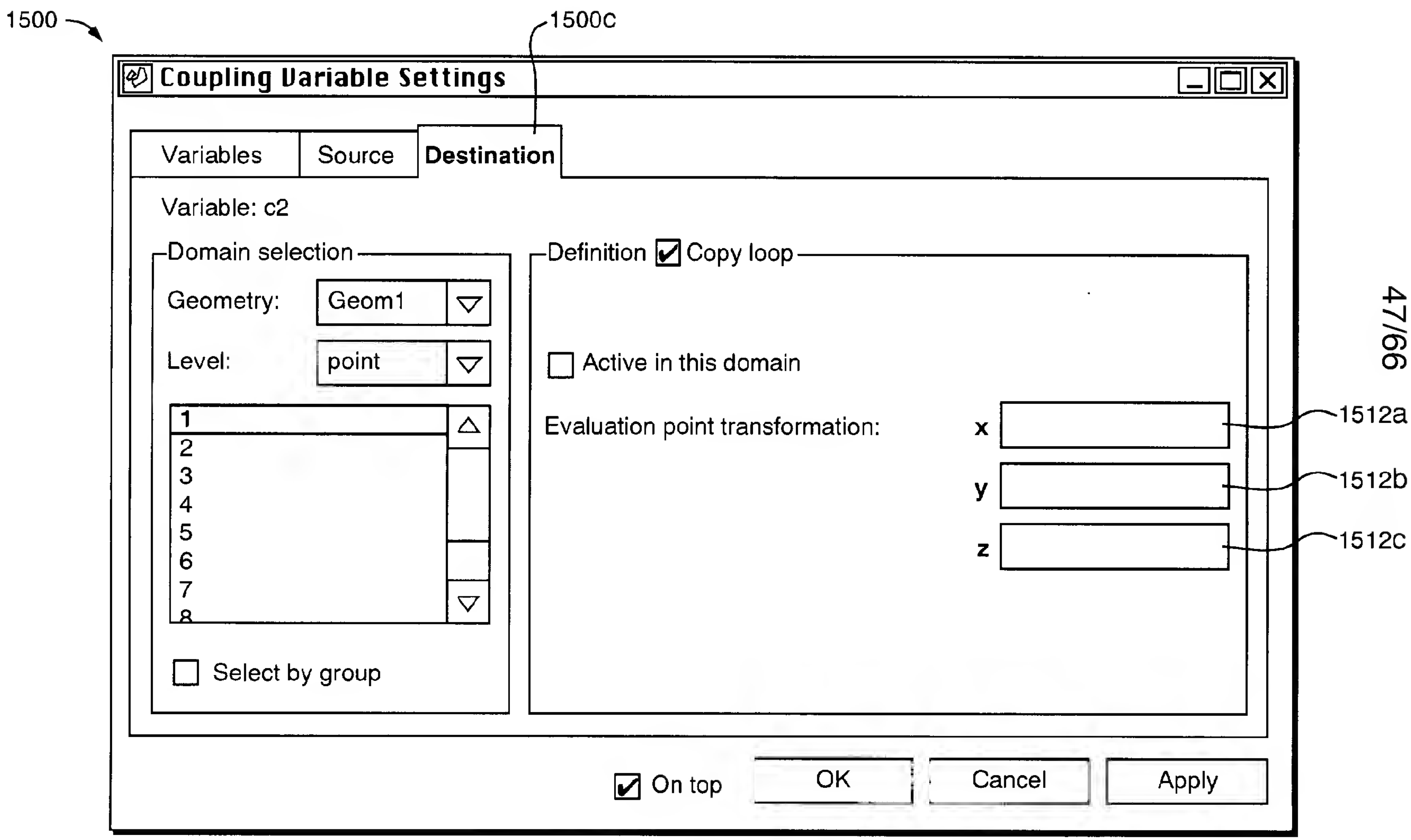

1500
1500b
Coupling Variable Settings
Variables
Source
Destination
Variable: c2
Domain selection
1502
Geometry:
Geom1
1504
Level:
boundary
1
2
3
4
5
6
7
8
1506
Select by group
Definition
Copy loop
1508
Expression:
Integration order:
Local mesh transformation:
x
y
z
1510a
1510b
1510c
On top
OK
Cancel
Apply

FIG. 45B



1500
1500c
Coupling Variable Settings
Variables
Source
Destination
Variable: c2
Domain selection
Geometry:
Geom1
Level:
point
1
2
3
4
5
6
7
8
Select by group
Definition
Copy loop
Active in this domain
Evaluation point transformation:
x
y
z
1512a
1512b
1512c
On top
OK
Cancel
Apply

FIG. 45C

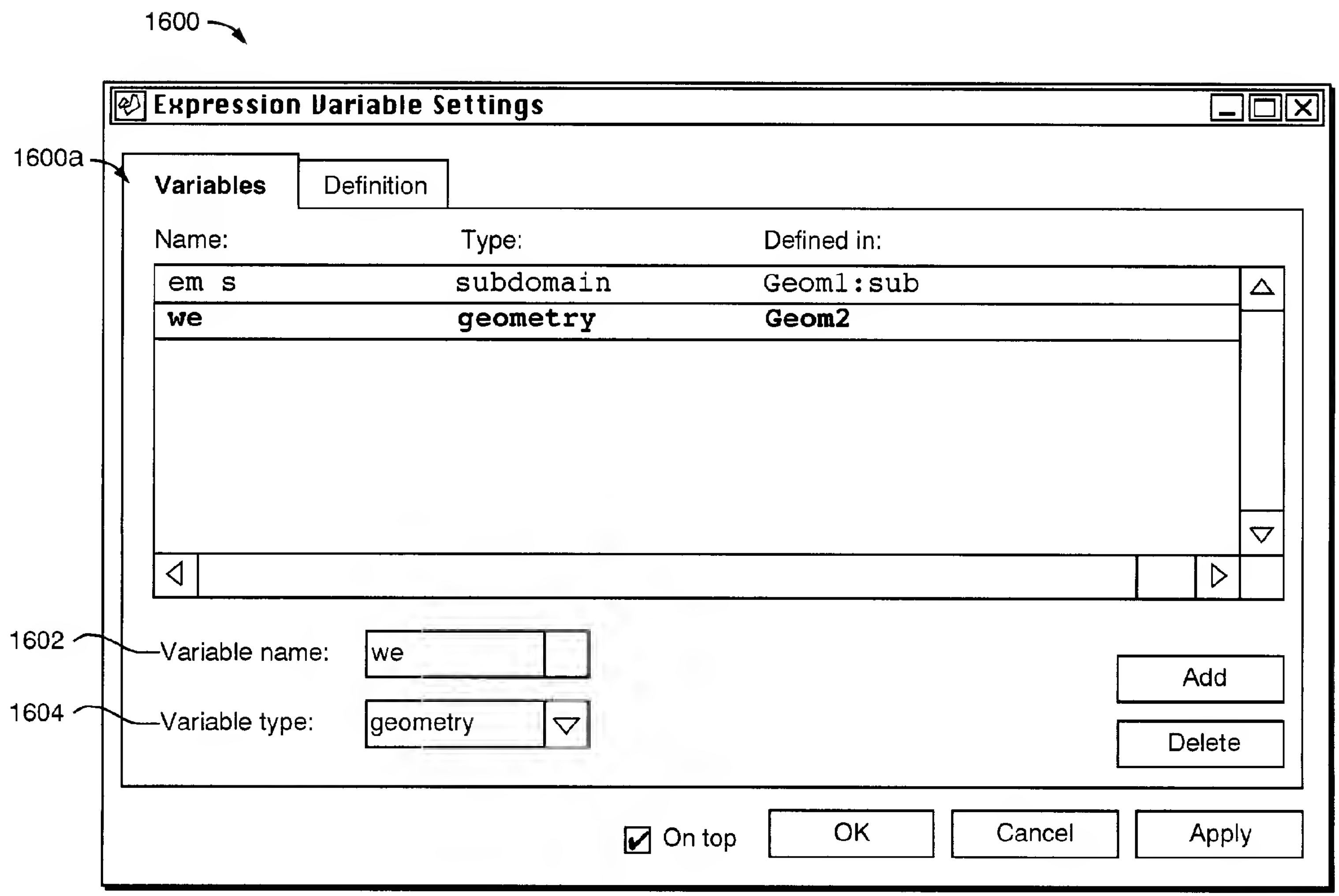

1600
1600a
Expression Variable Settings
Variables
Definition
Name:
Type:
Defined in:
em s
subdomain
Geom1:sub
we
geometry
Geom2
1602
Variable name:
we
1604
Variable type:
geometry
Add
Delete
On top
OK
Cancel
Apply

FIG. 46

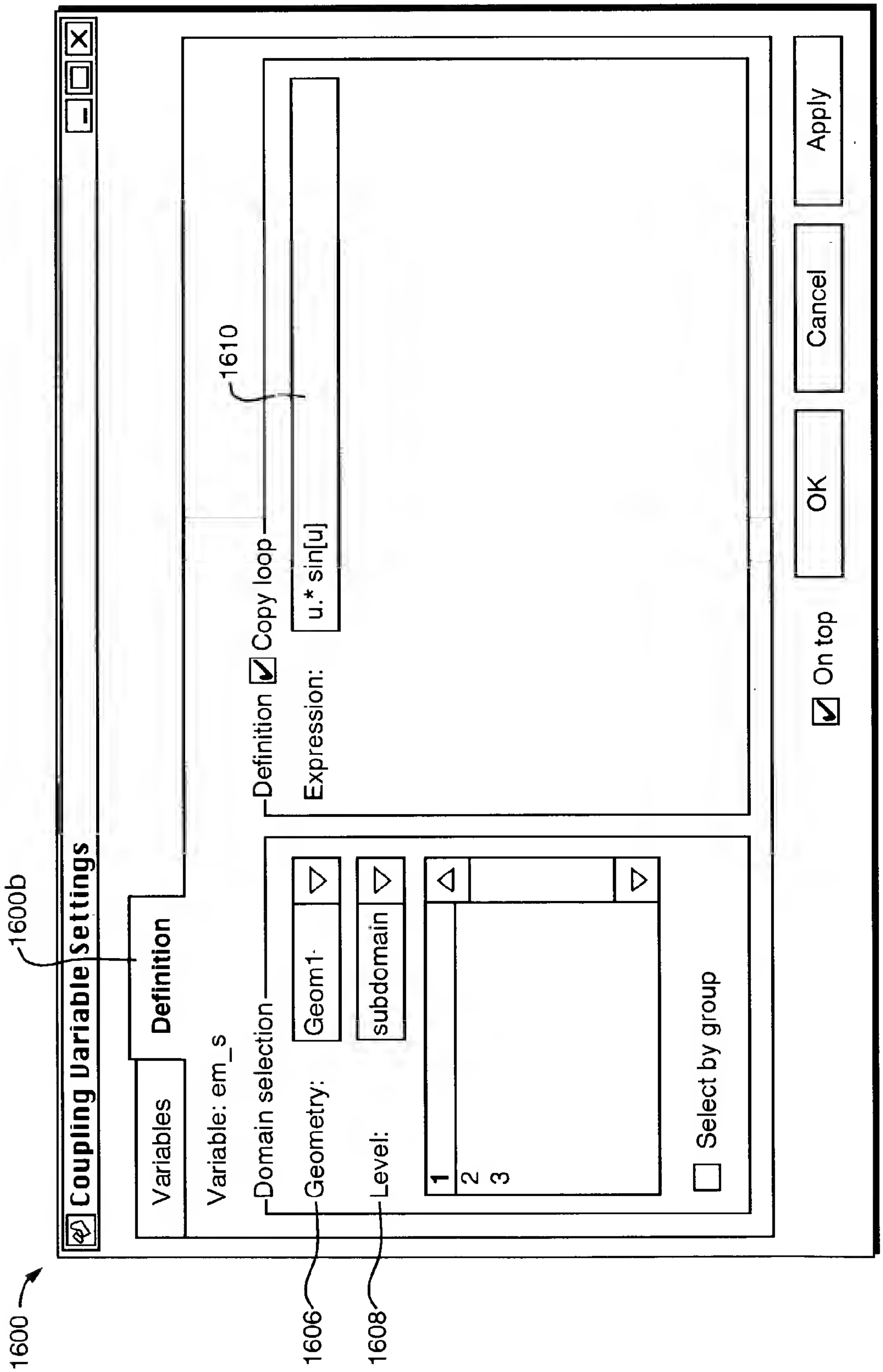

1600
1600b
Coupling Variable Settings
Variables
Definition
Variable: em_s
Domain selection
Geometry:
Geom1
Level:
subdomain
1
2
3
Select by group
1606
1608
Definition
Copy loop
Expression:
u.* sin[u]
1610
On top
OK
Cancel
Apply

FIG. 47

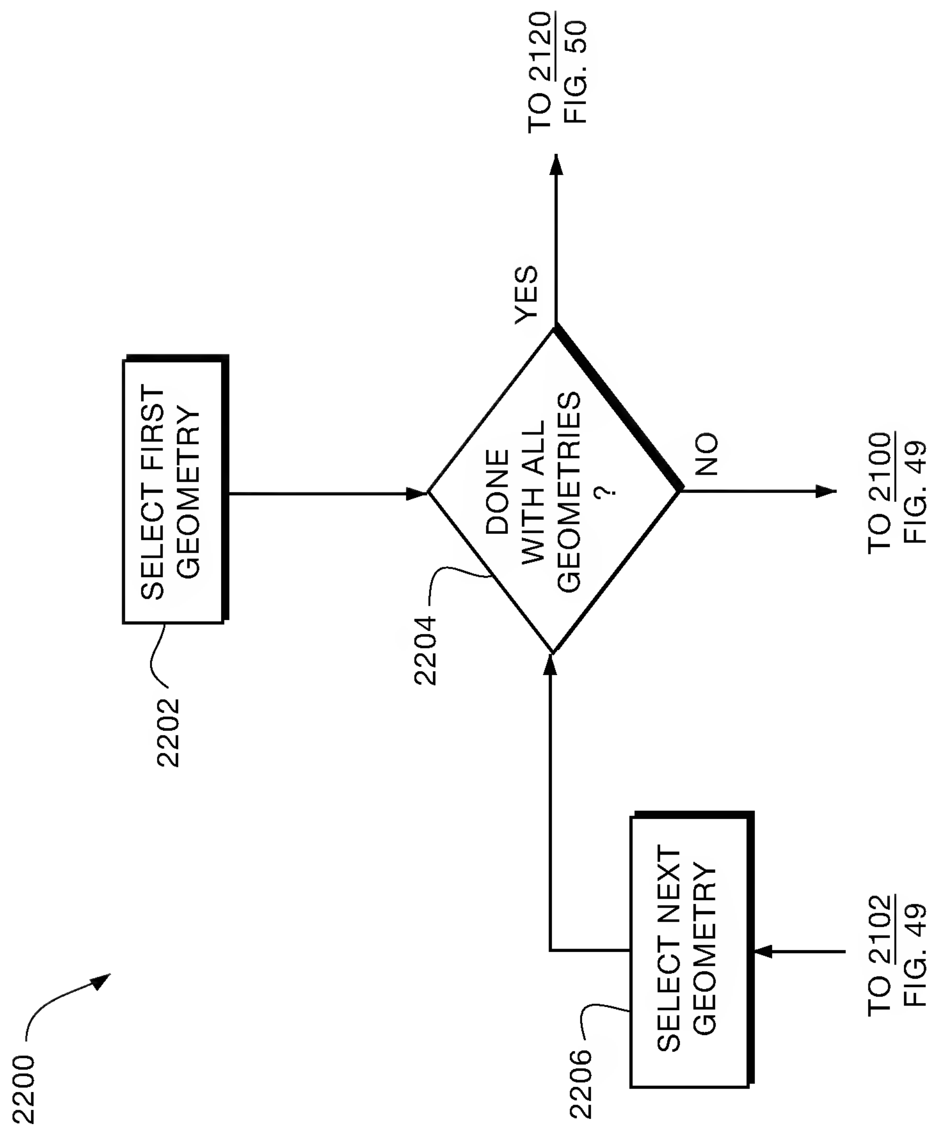
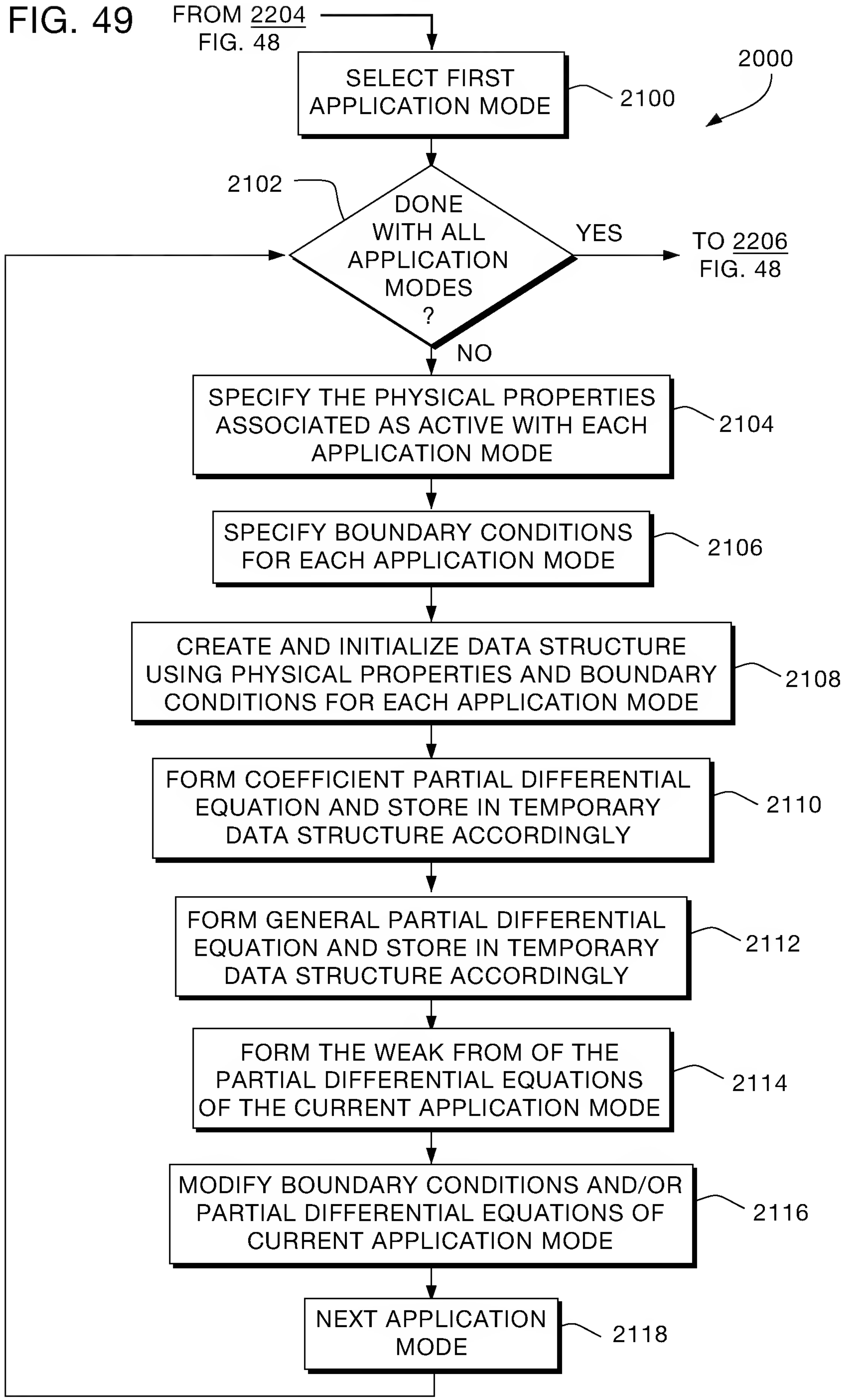

2200
SELECT FIRST GEOMETRY
2202
DONE WITH ALL GEOMETRIES ?
2204
YES
TO 2120 FIG. 50
NO
TO 2100 FIG. 49
SELECT NEXT GEOMETRY
2206
TO 2102 FIG. 49

FIG. 48

FIG. 49


FROM 2204 FIG. 48
SELECT FIRST APPLICATION MODE
2100
2000
2102
DONE WITH ALL APPLICATION MODES ?
YES
TO 2206 FIG. 48
NO
SPECIFY THE PHYSICAL PROPERTIES ASSOCIATED AS ACTIVE WITH EACH APPLICATION MODE
2104
SPECIFY BOUNDARY CONDITIONS FOR EACH APPLICATION MODE
2106
CREATE AND INITIALIZE DATA STRUCTURE USING PHYSICAL PROPERTIES AND BOUNDARY CONDITIONS FOR EACH APPLICATION MODE
2108
FORM COEFFICIENT PARTIAL DIFFERENTIAL EQUATION AND STORE IN TEMPORARY DATA STRUCTURE ACCORDINGLY
2110
FORM GENERAL PARTIAL DIFFERENTIAL EQUATION AND STORE IN TEMPORARY DATA STRUCTURE ACCORDINGLY
2112
FORM THE WEAK FROM OF THE PARTIAL DIFFERENTIAL EQUATIONS OF THE CURRENT APPLICATION MODE
2114
MODIFY BOUNDARY CONDITIONS AND/OR PARTIAL DIFFERENTIAL EQUATIONS OF CURRENT APPLICATION MODE
2116
NEXT APPLICATION MODE
2118

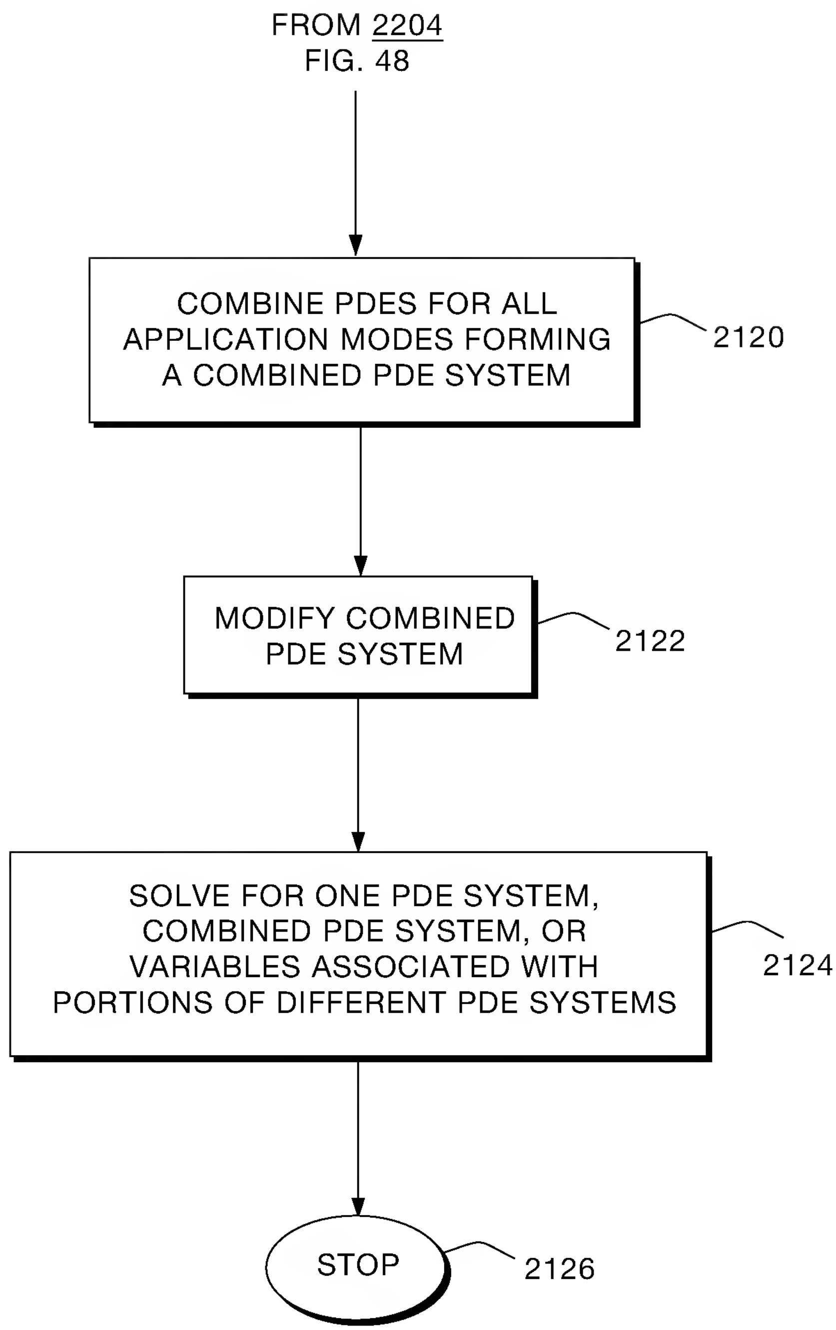

FROM 2204
FIG. 48
COMBINE PDES FOR ALL APPLICATION MODES FORMING A COMBINED PDE SYSTEM
2120
MODIFY COMBINED PDE SYSTEM
2122
SOLVE FOR ONE PDE SYSTEM, COMBINED PDE SYSTEM, OR VARIABLES ASSOCIATED WITH PORTIONS OF DIFFERENT PDE SYSTEMS
2124
STOP
2126

FIG. 50

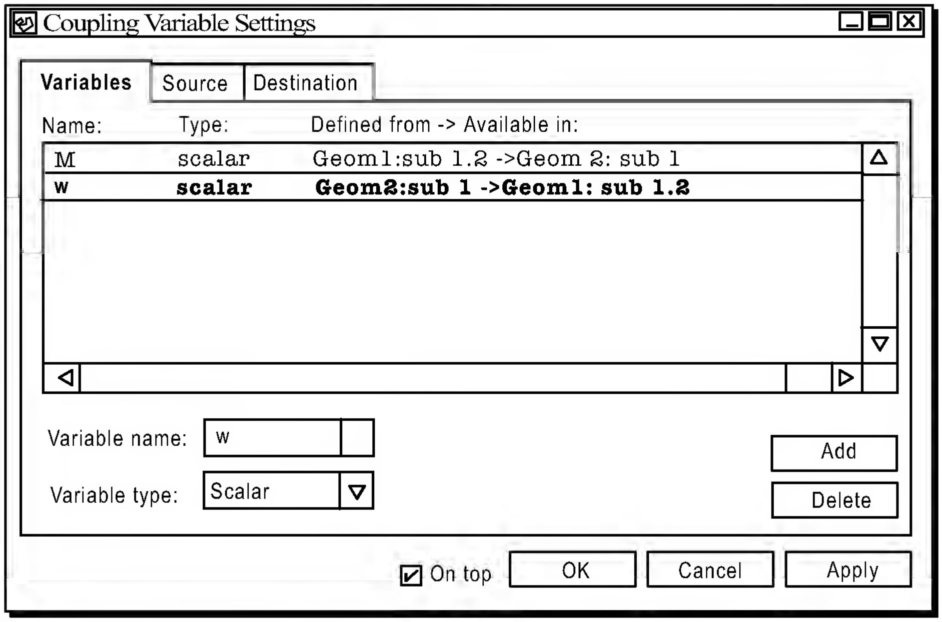

Coupling Variable Settings
Variables
Source
Destination
Name:
Type:
Defined from -> Available in:
M
scalar
Geom1:sub 1.2 ->Geom 2: sub 1
w
scalar
Geom2:sub 1 ->Geom1: sub 1.2
Variable name:
w
Variable type:
Scalar
Add
Delete
On top
OK
Cancel
Apply

FIG. 51

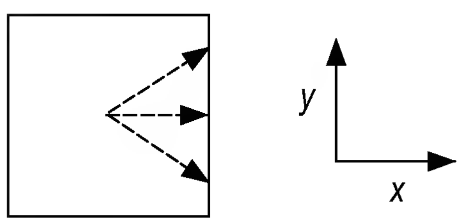

y
x

FIG. 52

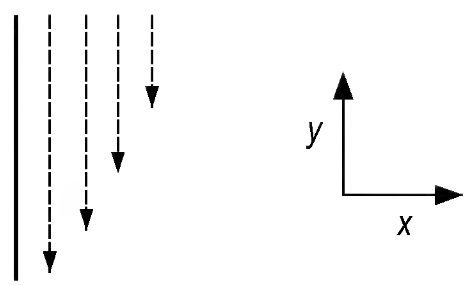


FIG. 53A

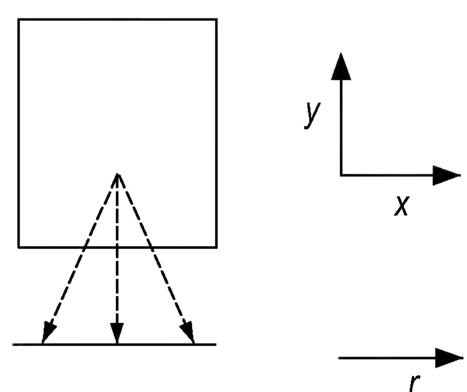


FIG. 53B

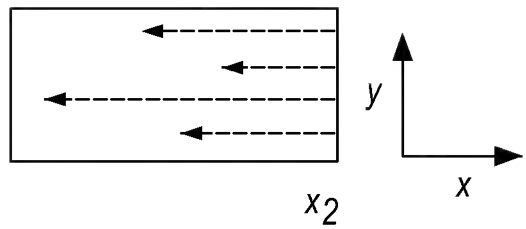


FIG. 54

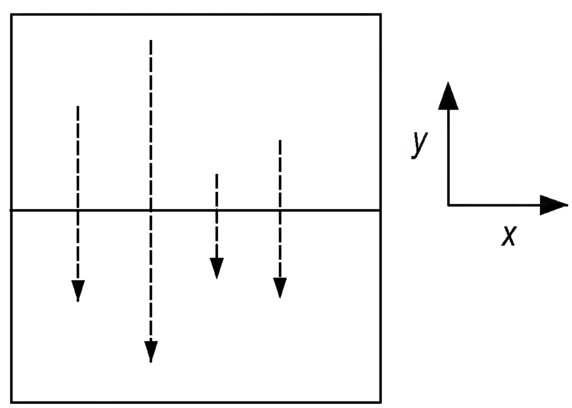


FIG. 55A

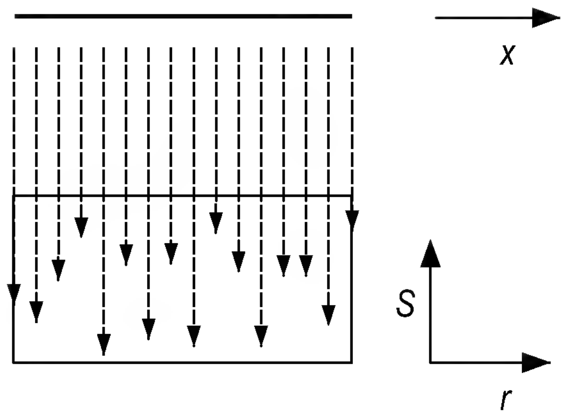


FIG. 55B

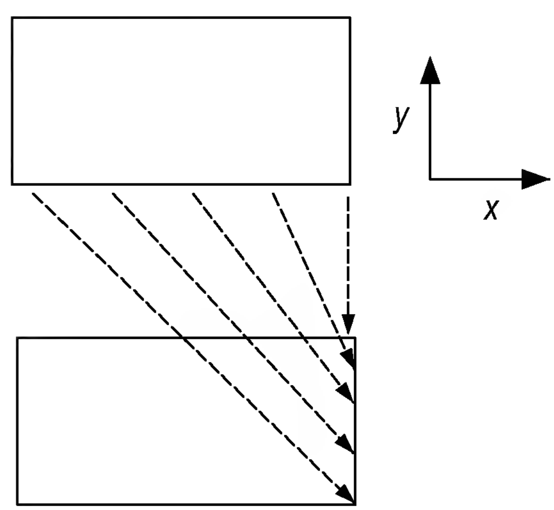


FIG. 55C

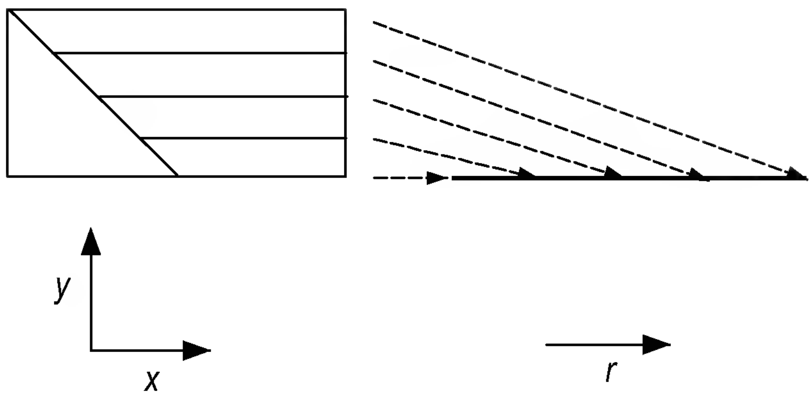


FIG. 56A

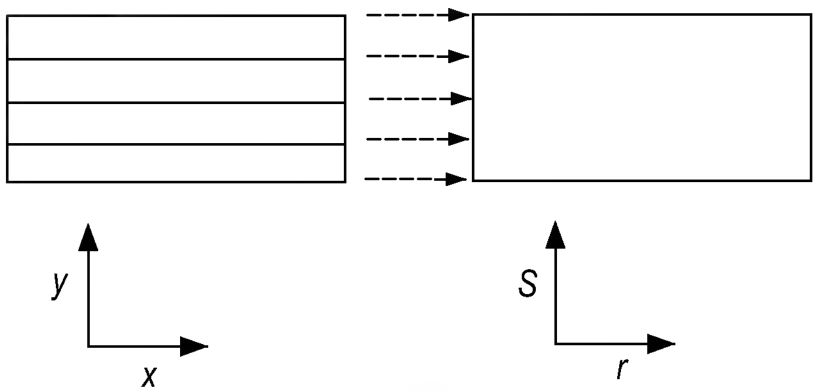


FIG. 56B

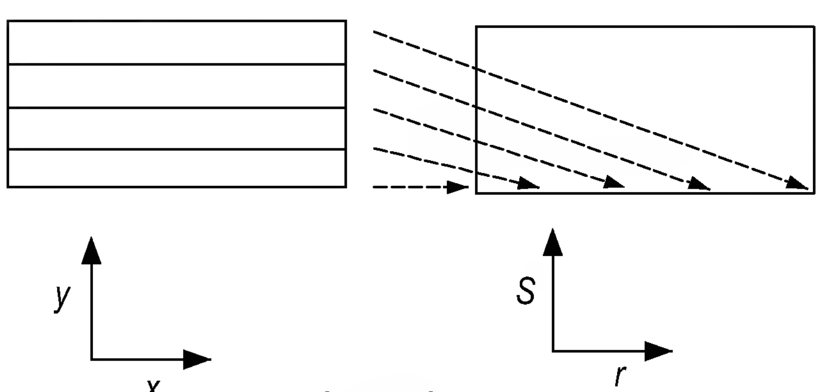


FIG. 56C

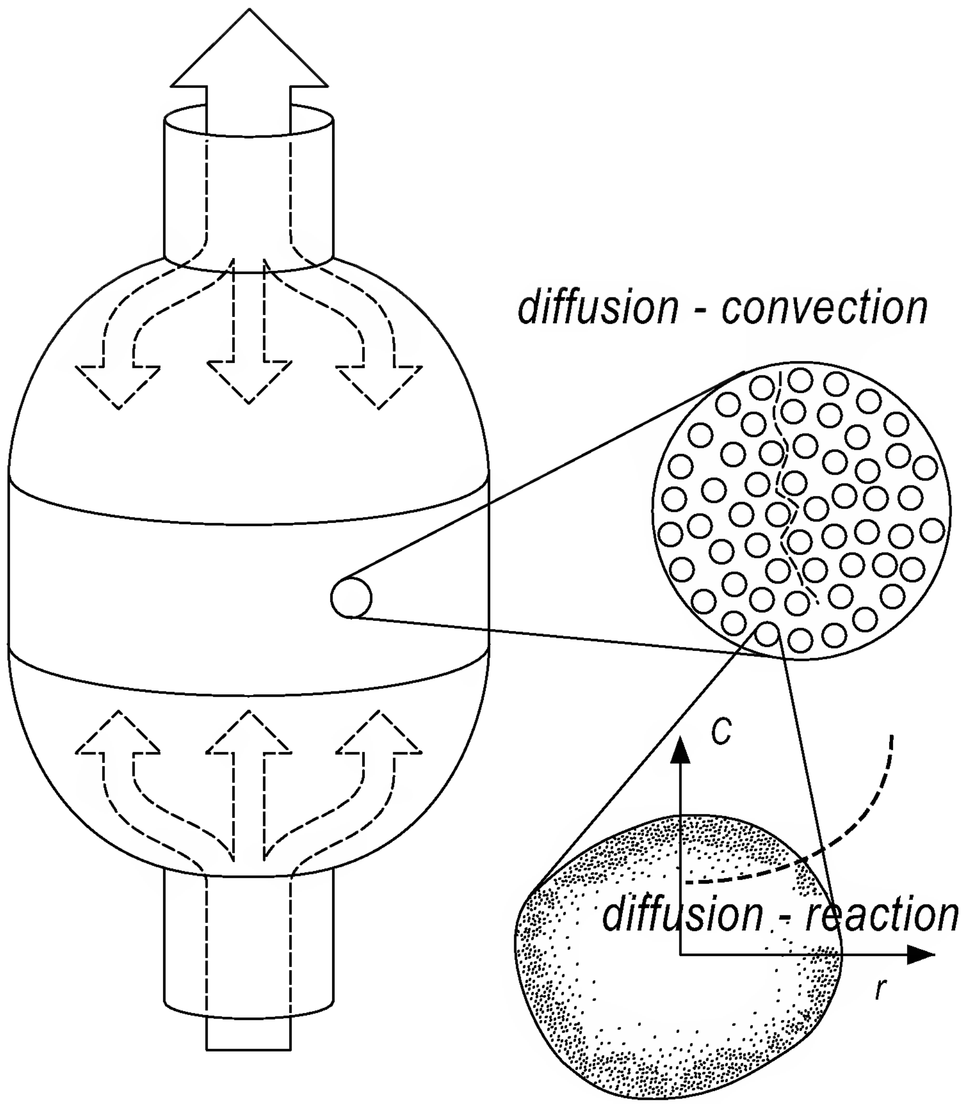


FIG. 57

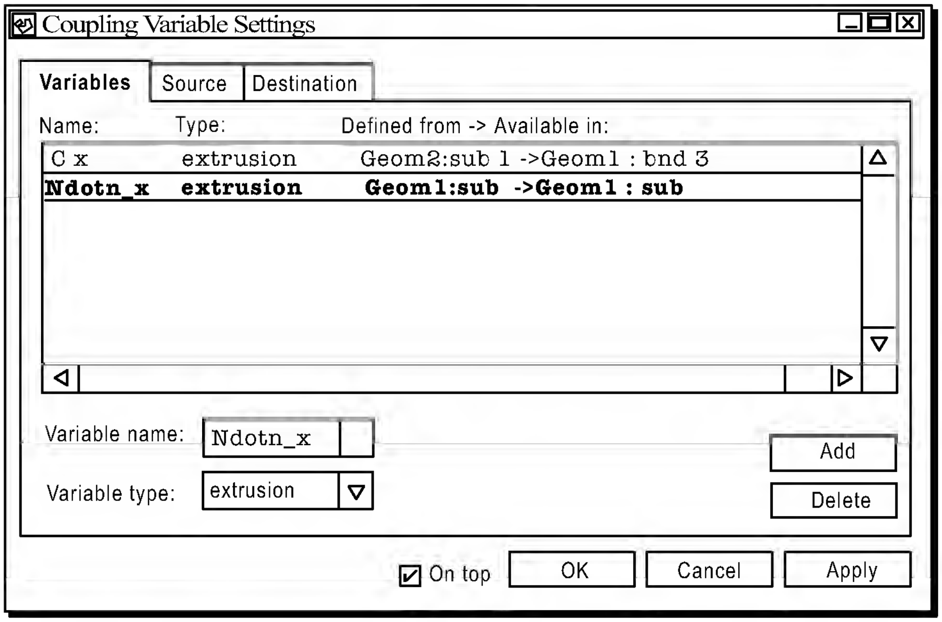

Coupling Variable Settings
Variables
Source
Destination
Name:
Type:
Defined from -> Available in:
C x
extrusion
Geom2:sub 1 ->Geom1 : bnd 3
Ndotn_x
extrusion
Geom1:sub ->Geom1 : sub
Variable name:
Ndotn_x
Add
Variable type:
extrusion
Delete
On top
OK
Cancel
Apply

FIG. 58

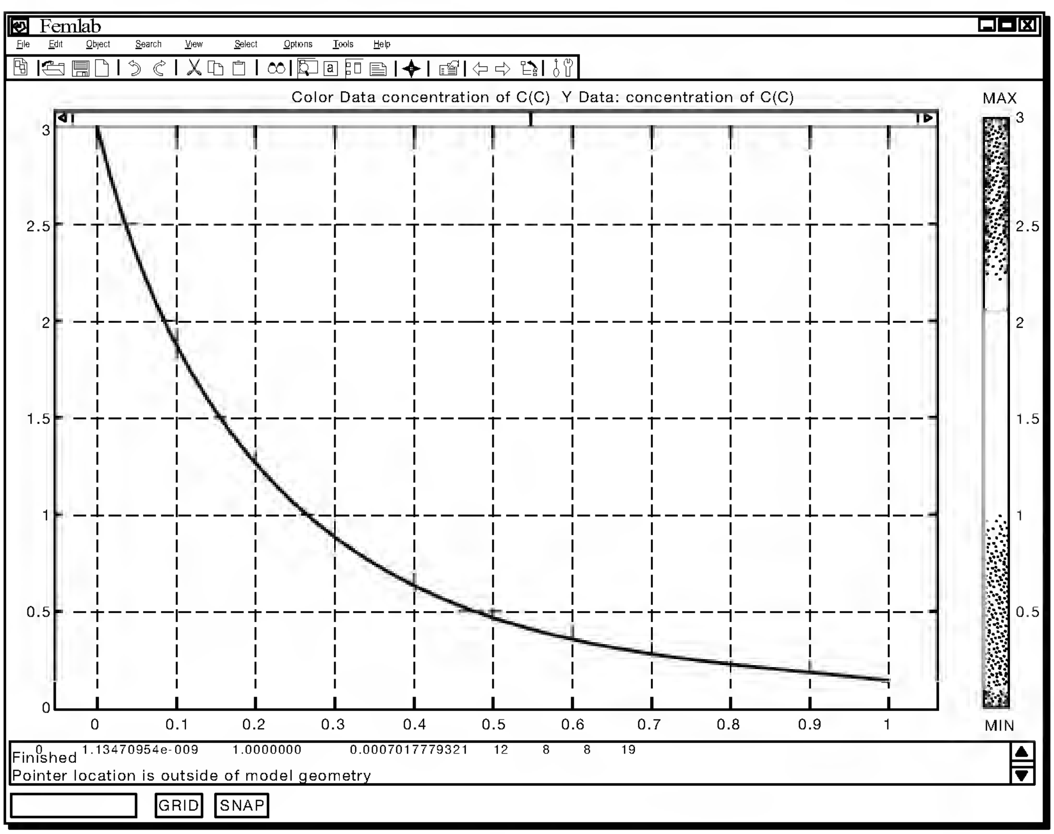

Femlab
File
Edit
Object
Search
View
Select
Options
Tools
Help
Color Data concentration of C(C) Y Data: concentration of C(C)
MAX
MIN
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1
1.5
2
2.5
3
Finished
1.13470954e-009
1.0000000
0.0007017779321
12
8
8
19
Pointer location is outside of model geometry
GRID
SNAP

FIG. 59

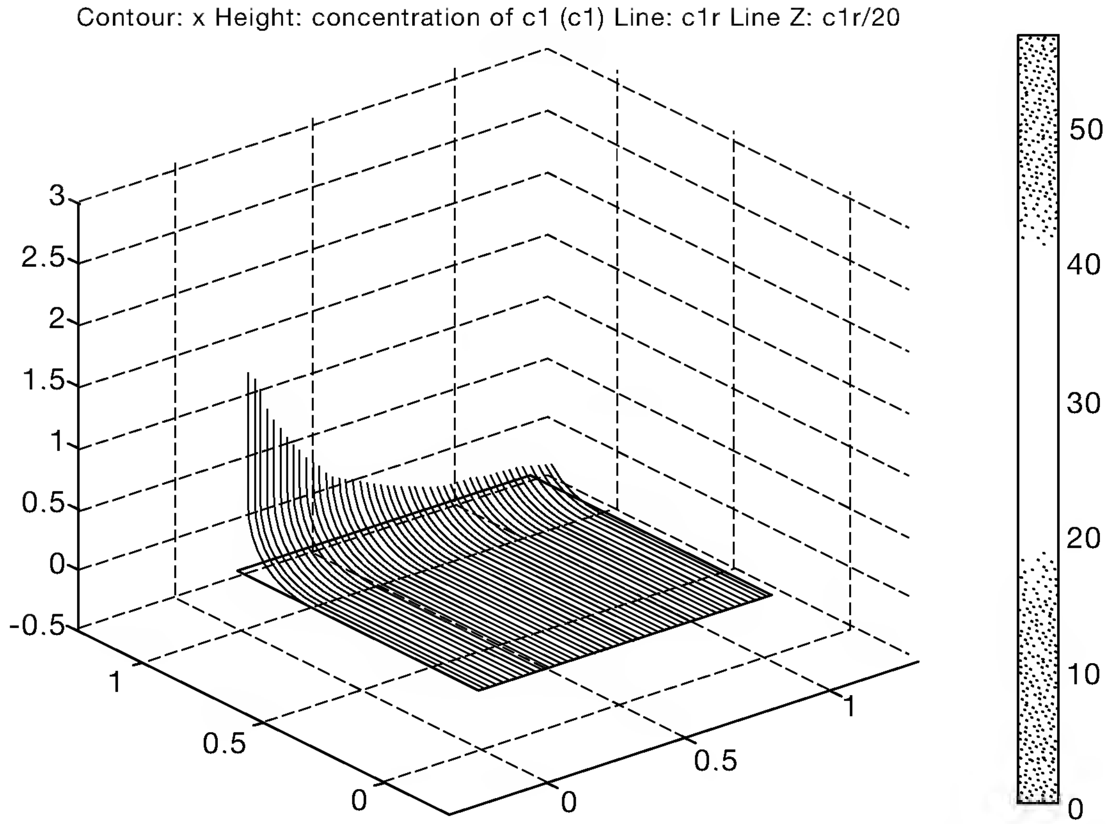

Contour: x Height: concentration of c1 (c1) Line: c1r Line Z: c1r/20
3
2.5
2
1.5
1
0.5
0
-0.5
1
0.5
0
0
0.5
1
50
40
30
20
10
0

FIG. 60

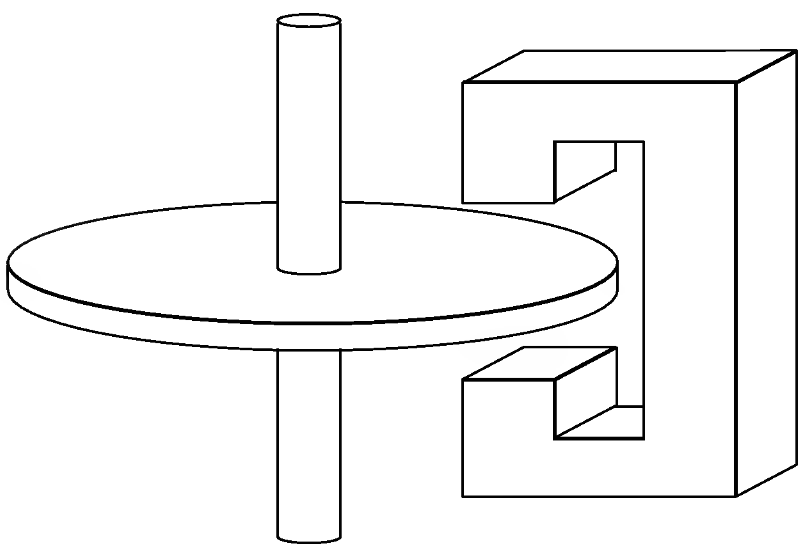


FIG. 61

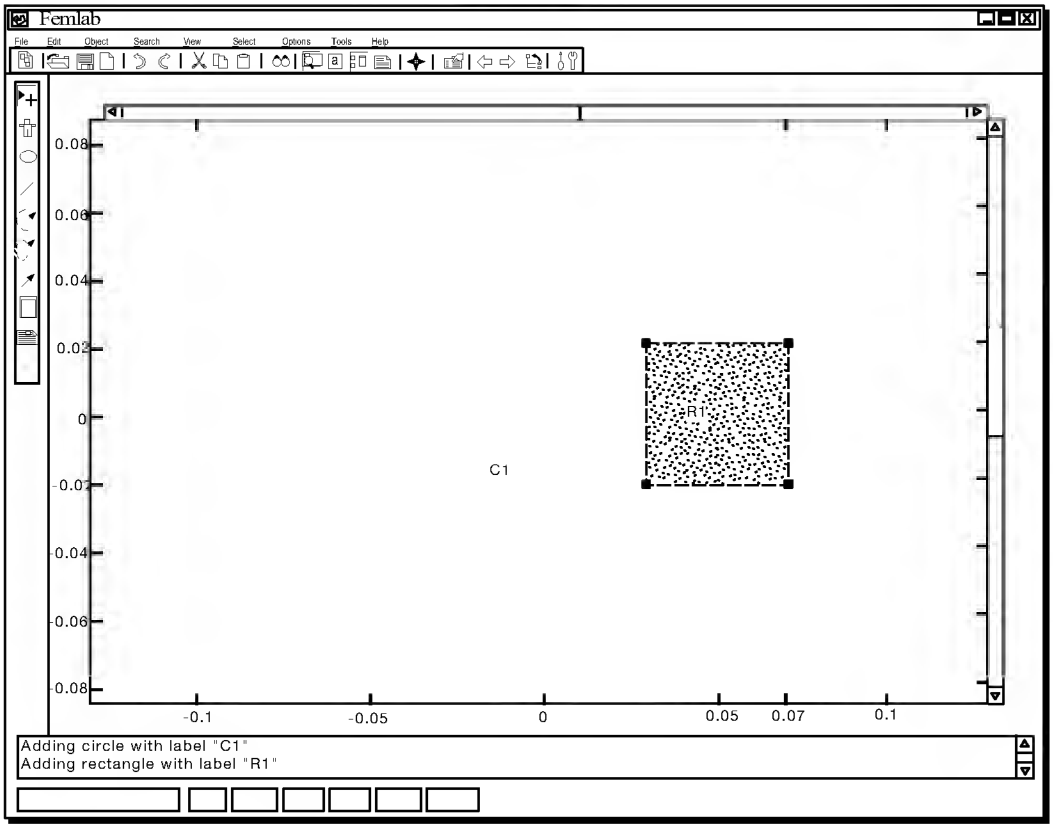

Femlab
File Edit Object Search View Select Options Tools Help
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
R1
C1
-0.1
-0.05
0
0.05
0.07
0.1
Adding circle with label "C1"
Adding rectangle with label "R1"

FIG. 62

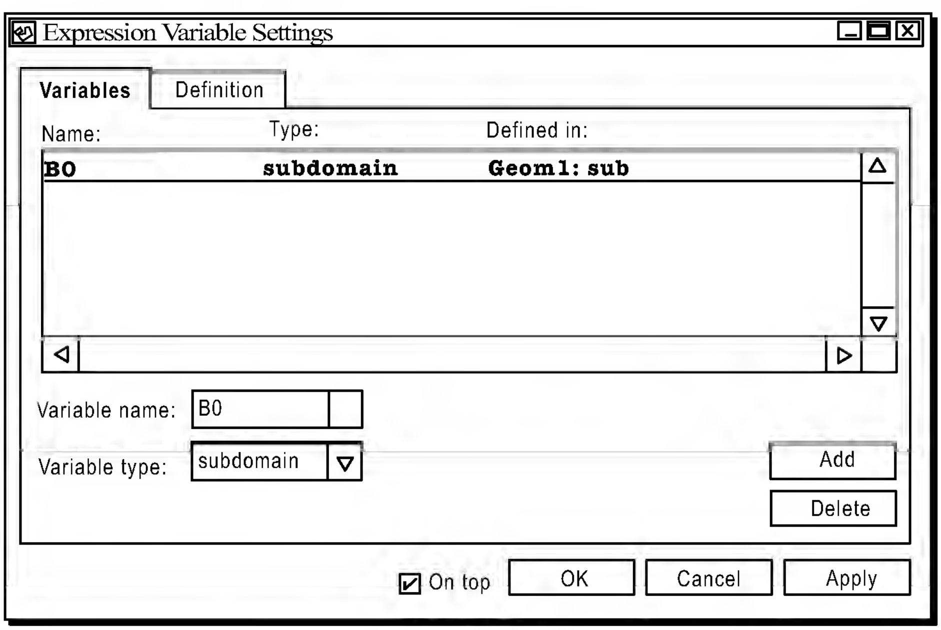

Expression Variable Settings
Variables
Definition
Name:
Type:
Defined in:
B0
subdomain
Geom1: sub
Variable name:
B0
Variable type:
subdomain
Add
Delete
On top
OK
Cancel
Apply

FIG. 63

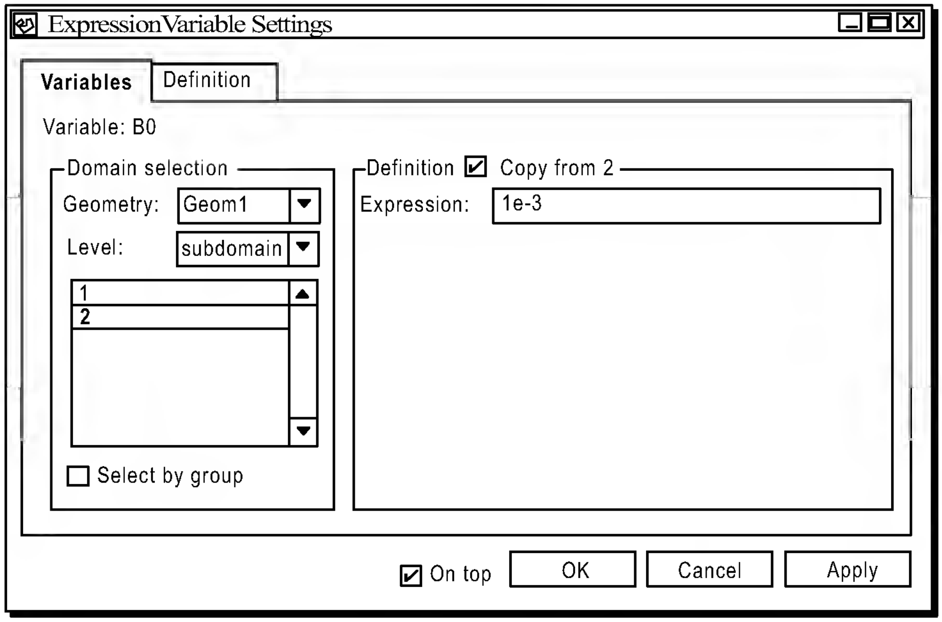

ExpressionVariable Settings
Variables
Definition
Variable: B0
Domain selection
Geometry:
Geom1
Level:
subdomain
1
2
Select by group
Definition
Copy from 2
Expression:
1e-3
On top
OK
Cancel
Apply

FIG. 64

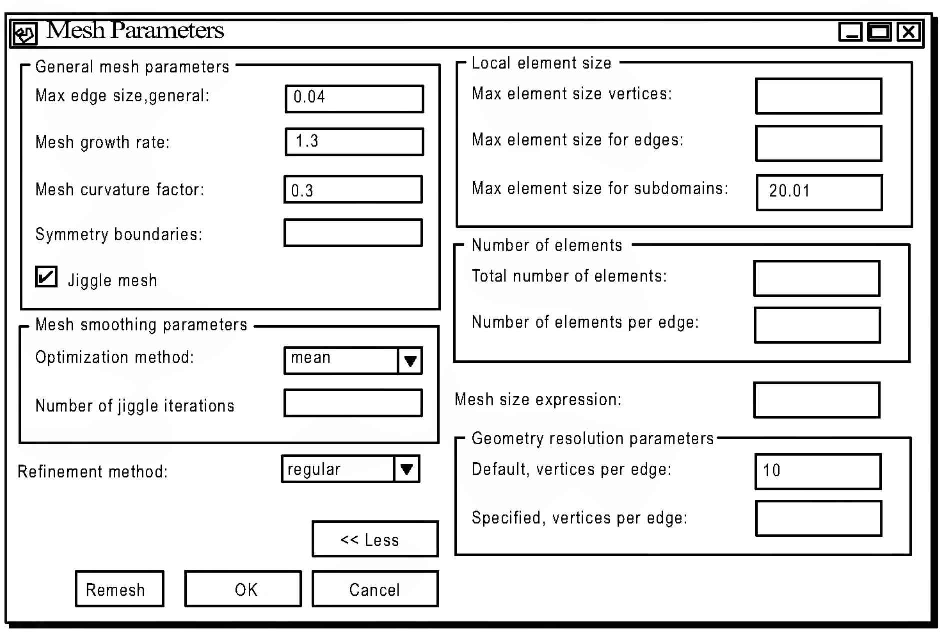

Mesh Parameters
General mesh parameters
Max edge size,general:
0.04
Mesh growth rate:
1.3
Mesh curvature factor:
0.3
Symmetry boundaries:
Jiggle mesh
Mesh smoothing parameters
Optimization method:
mean
Number of jiggle iterations
Refinement method:
regular
<< Less
Remesh
OK
Cancel
Local element size
Max element size vertices:
Max element size for edges:
Max element size for subdomains:
20.01
Number of elements
Total number of elements:
Number of elements per edge:
Mesh size expression:
Geometry resolution parameters
Default, vertices per edge:
10
Specified, vertices per edge:

FIG. 65

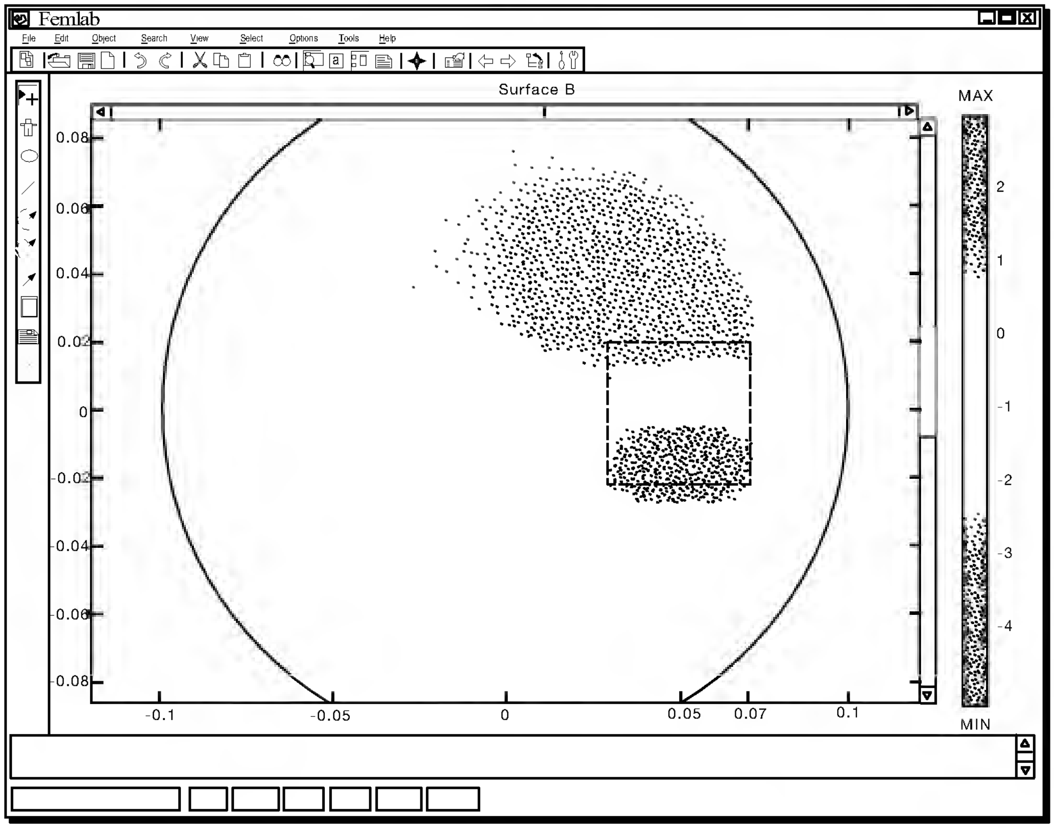

Femlab
File Edit Object Search View Select Options Tools Help
Surface B
MAX
MIN
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.05
0
0.05
0.07
0.1
2
1
0
-1
-2
-3
-4

FIG. 66

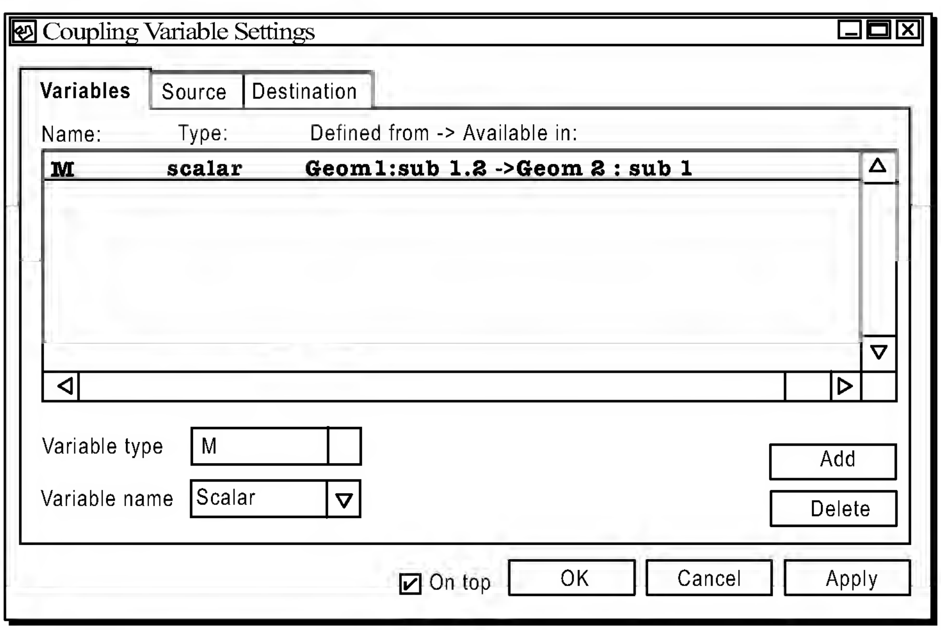

Coupling Variable Settings
Variables
Source
Destination
Name:
Type:
Defined from -> Available in:
M
scalar
Geom1:sub 1.2 ->Geom 2 : sub 1
Variable type
M
Variable name
Scalar
Add
Delete
On top
OK
Cancel
Apply

FIG. 67

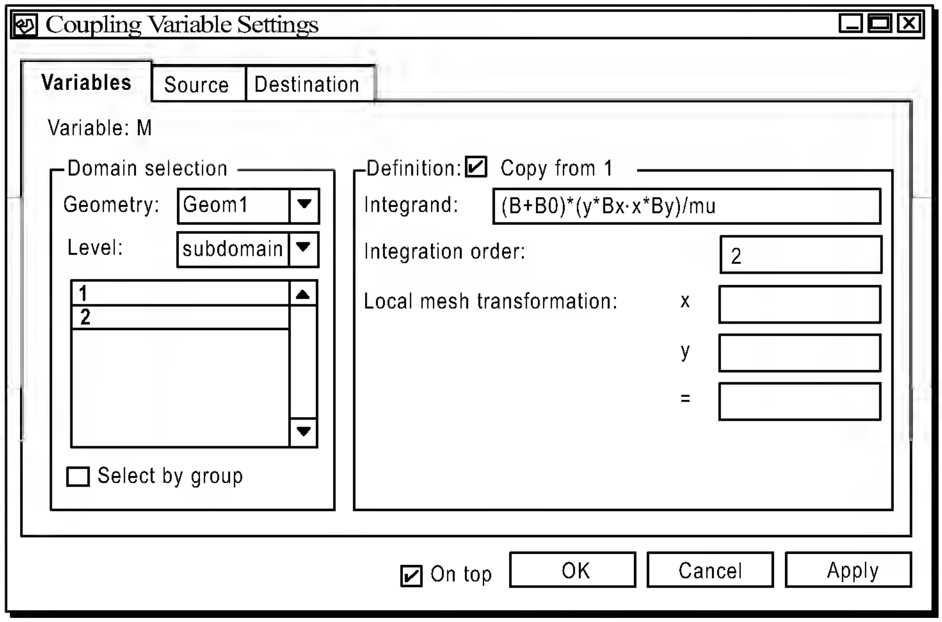

Coupling Variable Settings
Variables
Source
Destination
Variable: M
Domain selection
Geometry:
Geom1
Level:
subdomain
1
2
Select by group
Definition:
Copy from 1
Integrand:
(B+B0)*(y*Bx-x*By)/mu
Integration order:
2
Local mesh transformation:
x
y
=
On top
OK
Cancel
Apply

FIG. 68

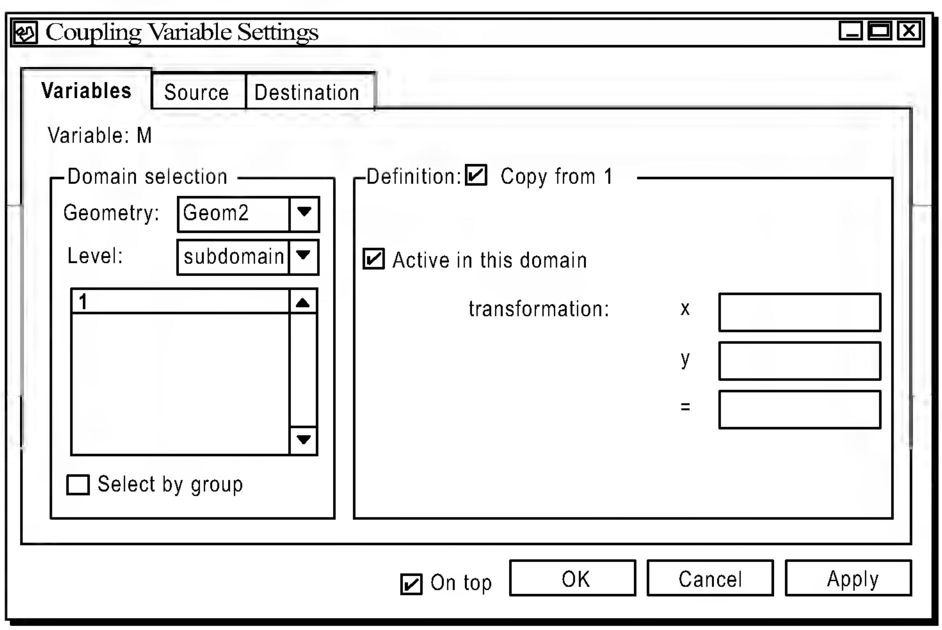

Coupling Variable Settings
Variables
Source
Destination
Variable: M
Domain selection
Geometry:
Geom2
Level:
subdomain
1
Select by group
Definition:
Copy from 1
Active in this domain
transformation:
x
y
=
On top
OK
Cancel
Apply

FIG. 69

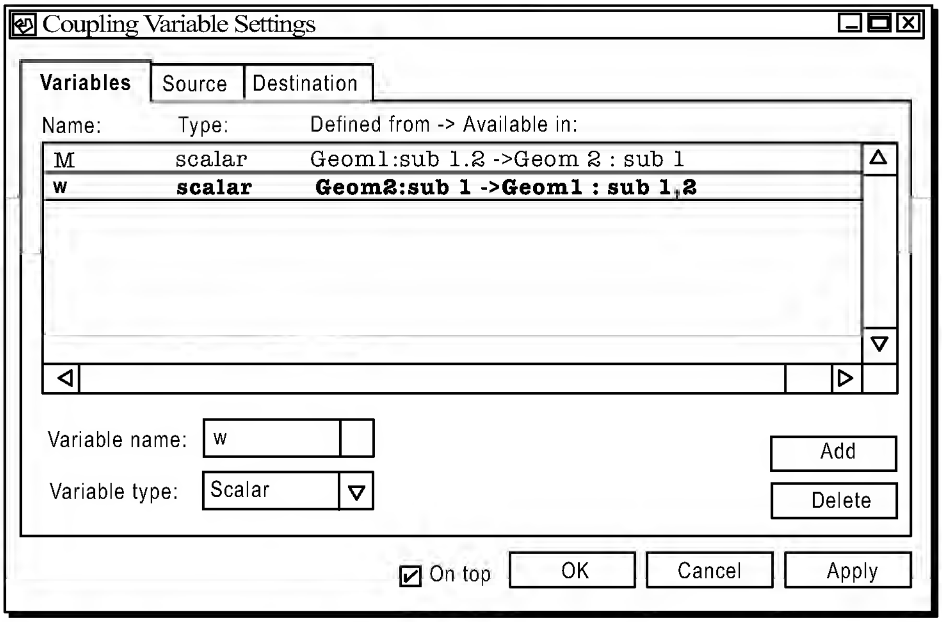

Coupling Variable Settings
Variables
Source
Destination
Name:
Type:
Defined from -> Available in:
M
scalar
Geom1:sub 1.2 ->Geom 2 : sub 1
w
scalar
Geom2:sub 1 ->Geom1 : sub 1,2
Variable name:
w
Add
Variable type:
Scalar
Delete
On top
OK
Cancel
Apply

FIG. 70

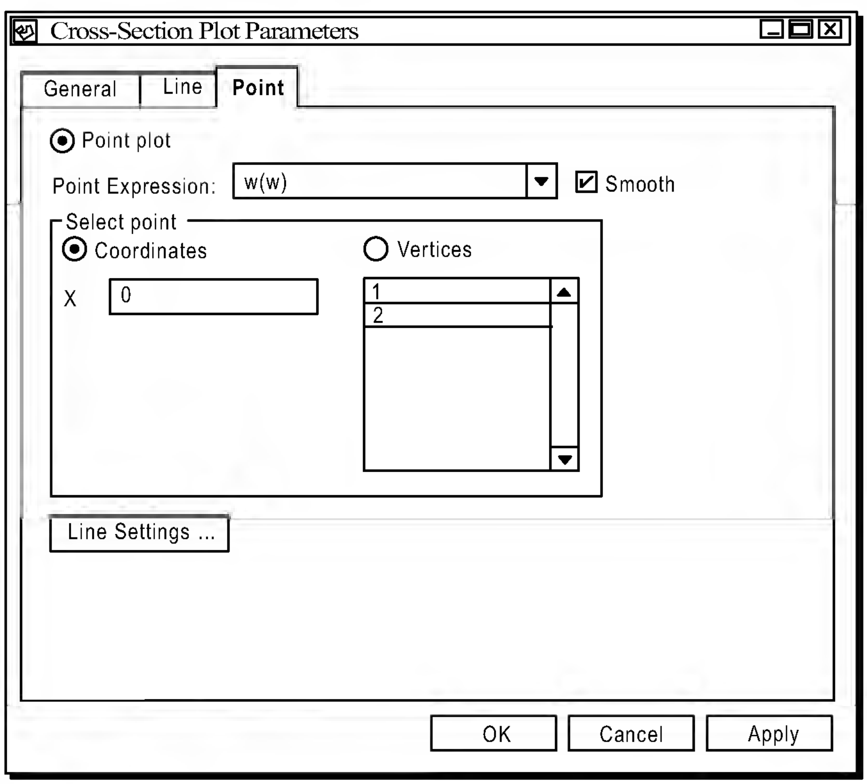

Cross-Section Plot Parameters
General
Line
Point
Point plot
Point Expression:
w(w)
Smooth
Select point
Coordinates
Vertices
X
0
1
2
Line Settings ...
OK
Cancel
Apply

FIG. 71

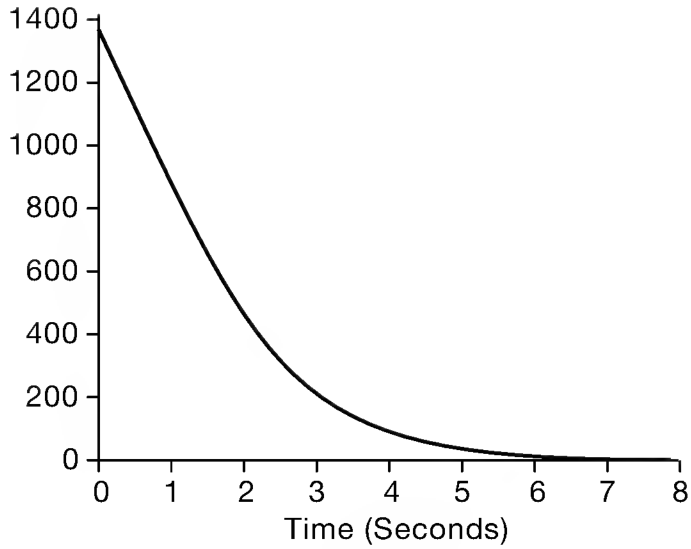


FIG. 72A

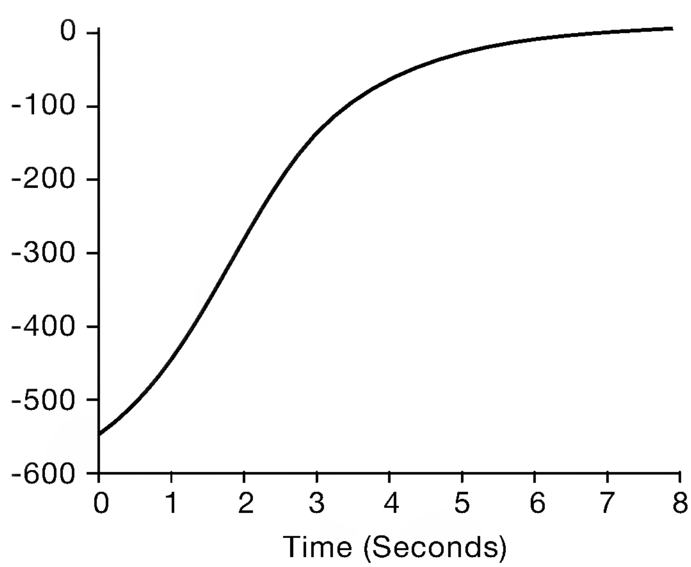


FIG. 72B